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MARINE ENGINEERING.

Vol. 3. NEW YORK, JUNE, 1899. No. 6.

TORPEDO-BOAT DESTROYER FARRAGUT—FASTEST VESSEL IN THE NAVY.

Our frontispiece shows U. S. S. *Farragut*, the first American torpedo-boat destroyer, complete, equipped and ready for sea. This fine boat, which is the fastest in our Navy, was recently tried and accepted by the Government on the Pacific Coast, she having been built by the Union Iron Works. The contract for this boat was signed October 5th, 1896, and the keel of the vessel was laid July 26th, 1897. She was launched July 16th, 1898, and delivered to the Government December 31st last. Her dimensions are: Length, 214 ft. over all; beam, 20 ft.; draught, 5 ft. 7 in.; and trial displacement, 240 tons.

She is fitted with twin screw engines of the four cylinder, four crank, triple expansion type, with cylinders 20 in., 29 in., and two 30 in. dia. and 18 in. stroke. The air pumps are driven direct from the crank shafts by an extension at the forward end of each. The en-

U. S. S. FARRAGUT GETTING UNDER WAY AND STEAMING FULL SPEED ON TRIAL.

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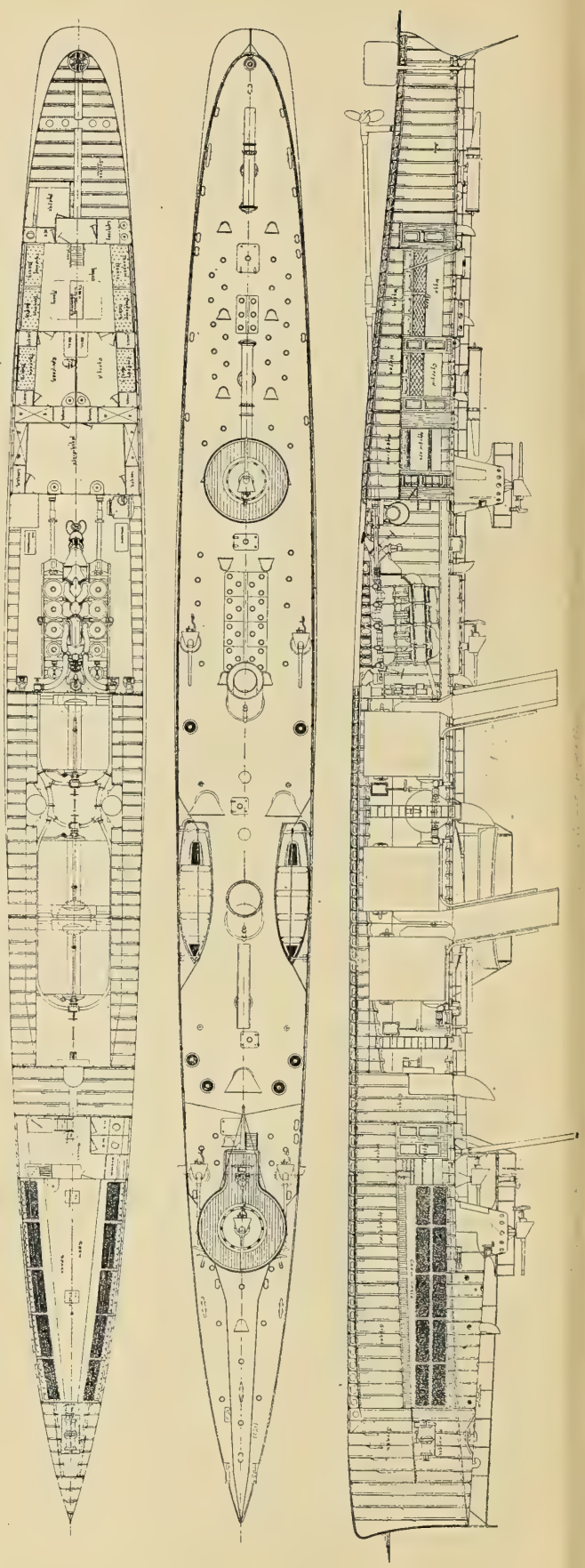
gines are of course designed with a view to getting the maximum power on the minimum weight. Hollow forgings are extensively used, including the crank shafts, each of which is in one piece with the eccentrics forged on. Very complete arrangements for oiling are provided, including centrifugal oilers for the crank pins, and large tubes down the sides of the connecting rods. The main condenser has a copper shell and is placed between the engines with scoops at both ends connected with openings in the bottom, through which the circulating water is forced by the motion of the vessel when steaming. A small circulating pump in the form of a two-bladed propeller is placed in the after scoop to start the circulation when the destroyer is starting out or lying at anchor. The boilers are three in number, of the Thornycroft type, each rated at 2,000 horse power with 240 pounds pressure. The *Farragut* also carries a distilling plant in the engine room.

The propellers are three-bladed, of solid bronze, and are carried by forged steel struts far below the keel line, the vessel being cut away tremendously aft, as shown in the outline drawings. They are 6 ft. 9 in. dia. and 8 ft. 9 in. pitch, and they turn up 420 revolutions when the boat is going full speed.

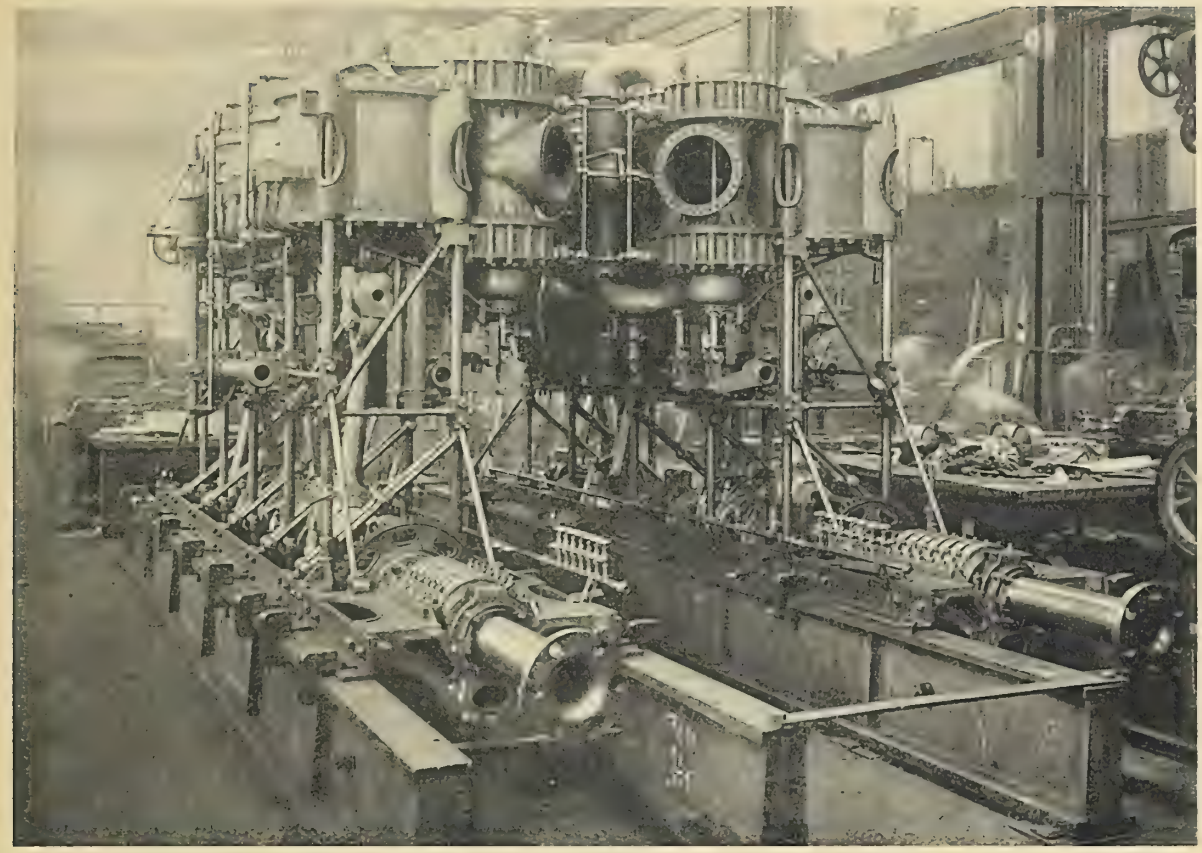
In the shape of armament she is fitted with three 6-pound rapid-fire guns, two 15 in. torpedo tubes. There is a small conning tower forward and another aft. Six torpedoes are carried stowed away forward under the turtle back.

On trial the *Farragut* showed an average rate of speed of 30.6 knots. The contract price for the hull and machinery was $227,500.

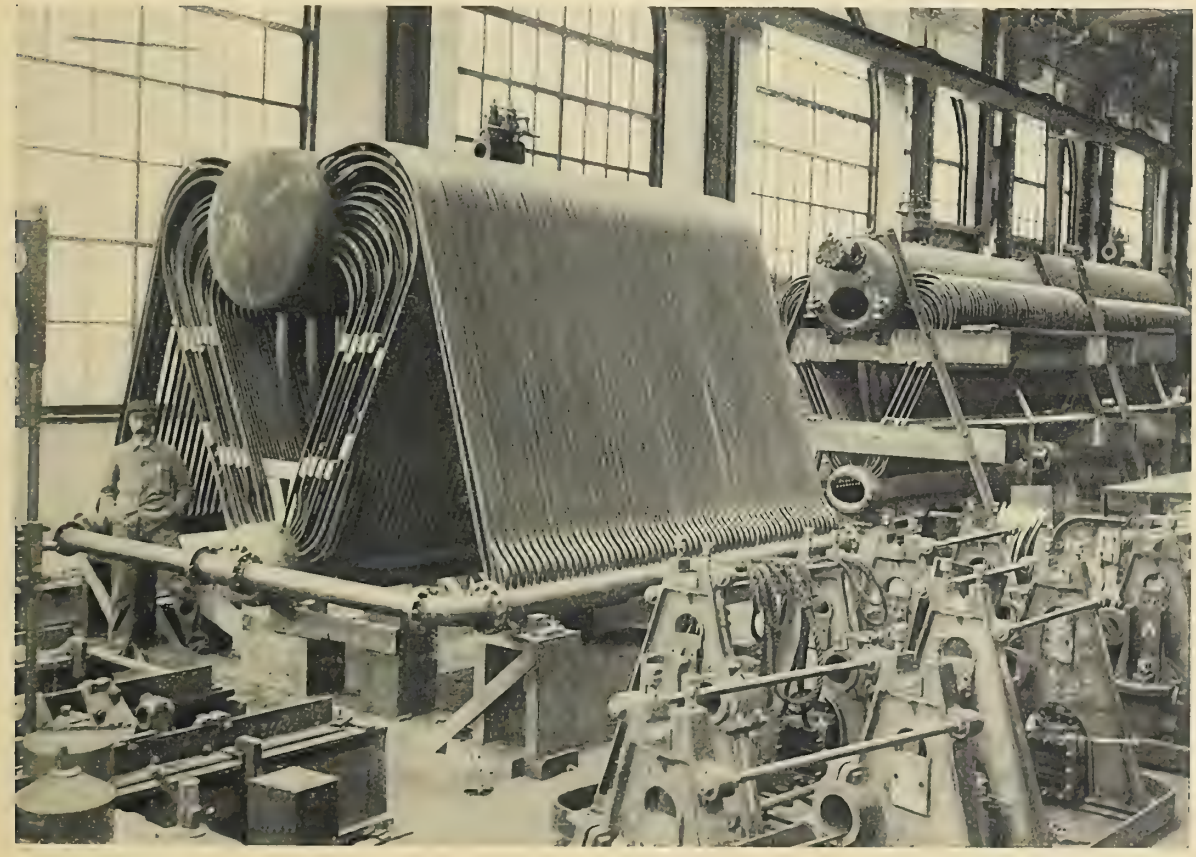
Published designs of the new royal yacht *Victoria and Albert* for Queen Victoria show an antiquated looking vessel, following very closely in general appearance the present side wheel vessel of the same name. The new vessel was launched at Pembroke Dock Yard, May 9, by the Duchess of York. She was designed by Sir William White, Chief Constructor of the British Navy, with the view of being used exclusively as a yacht; so that the vessel will not be a combination of warship and pleasure craft, as is the case with yachts of other monarchs. Considered therefore as a yacht pure and simple she is the largest vessel of this type afloat. Her dimensions are: Length, 420 ft.; between perpendiculars, 380 ft.; beam, 50 ft., and displacement 4,700 tons on 18 ft. draught of water. It was undoubtedly the wish of her royal owner that the new vessel should be designed so as to closely resemble the present *Victoria and Albert*, for in other respects the new vessel is strictly up-to-date. She will be fitted with Belleville water-tube boilers, and two sets of four-cylinder, triple-expansion engines of 11,000 collective horse power, driving twin screws. Her sea speed will be about 17 knots, but she will be capable of spurts of 20 knots. She will be sheathed and coppered, but will carry neither armor nor armament, except possibly a couple of small guns for saluting purposes. She will have high sides with large square ports running her entire length fore and aft; a clipper bow, and overhung stern, and two smoke pipes with bellmouth tops.



INBOARD PROFILE AND DECK PLANS OF THE TORPEDO-BOAT DESTROYER FARRAGUT BUILT AND ENGINED BY THE UNION IRON WORKS.



TWIN-SCREW ENGINES OF THE TORPEDO BOAT DESTROYER FARRAGUT—AFTER ENDS.



THORNYCROFT BOILERS UNDER CONSTRUCTION FOR U. S. S FARRAGUT.

SHIPBUILDING AND SHIPPING CONDITIONS OF THE UNITED STATES.—PAST, PRESENT AND FUTURE.

BY GEO. R. M'DERMOTT N.A.

From time to time the writer's opinions have been sought as to the prospects of the shipbuilding and shipping interests generally of the United States. In view of recent events connected with our late conflict with Spain, resulting in the acquisition of new territories, the development of whose resources render necessary large additions to our mercantile marine, the presentment of a few facts connected with the shipbuilding and shipping affairs of the country may prove of interest and possibly serve a useful purpose in determining capitalists and others to lend their aid toward the resuscitation and upbuilding of a mercantile marine, too long neglected, that was once the nation's pride.

Before investing money in any industry the capitalist is naturally anxious to obtain the fullest information regarding the conditions which affect that particular industry, the chief consideration being as to whether the present is the most favorable time for investment.

In shipbuilding, as in other established branches of trade and commerce, an intelligent study of the progress of the industry in the past—noting at the same time the various causes for the rise and fall in the general tendency towards full development—is the surest guide to the financier in determining the soundness and probable fate of any scheme which may be placed before him. In investigations of this kind it is desirable to extend inquiries as far back as possible, so as to obtain correct ideas of the general trend of progress as apart from the periodic fluctuations which occur at almost regular intervals in all industries, and, owing to the vicissitudes through which American shipping interests have passed, such a mode of procedure is of paramount importance.

Shipbuilding and shipowning interests are interdependent, and, although we are, here, primarily interested in the former, our investigations must extend to both fields, as the fate of one depends upon the condition of the other. Preceding, however, to our inquiries: An exposition of the facts is shown geographically in the accompanying diagrams, which have been prepared from various governmental and other reliable statistics, showing in concise form the history of American Shipping. Diagram A shows the tonnage of American shipping engaged in foreign trade during the period 1797-1898. From this we learn that in 1797 about 600,000 tons were engaged; this increased year by year up to 1810, when 981,000 were so employed. About this time, however, strained relations with Britain—culminating in the year 1812—had the effect of reducing slightly the amount of our foreign trade, dropping, as shown by average curve, to be-

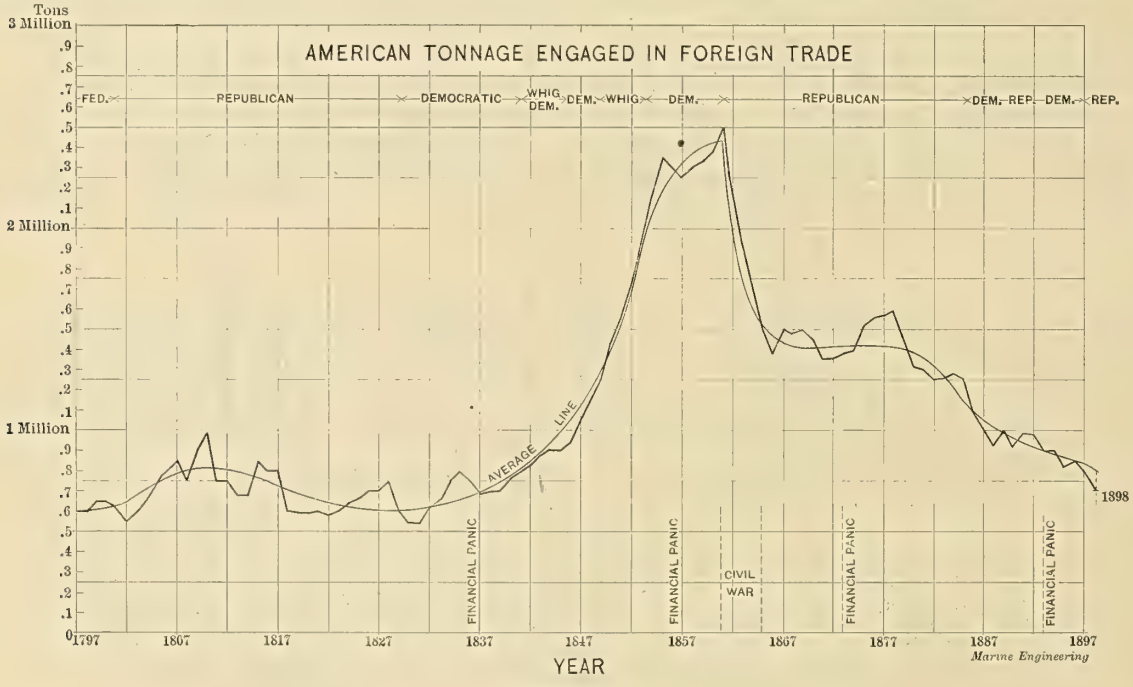


DIAGRAM A.

tween 600,000 and 700,000 tons; this average being maintained generally until about 1832, when we find an upward tendency at an annually increasing rate to 1861, when it amounted to 2 1-2 million tons. This rapid rise was probably due, to a large extent, to the fact that during this period Europe was engaged in almost continual warfare, one country with another. In 1861, however, came the civil war, and the wealth and spirit of the country and its patriotic sons were all centered in that unfortunate episode in the nation's life. Privateers, fitted out by Southerners, tacitly supported by the British, harassed and crippled our Merchant Marine to such an extent that those persons engaged in shipping had neither the heart nor the means to continue, and selling out became general. Although the civil war was the pri-

mary cause of the decline of our marine in foreign waters, it may be pointed out that Britain had been quietly engaged in developing her large mineral resources and employing them in the construction of iron vessels which, entering into competition with our wooden vessels, ultimately drove them out of business. Had the civil war not occurred it is more than probable that this country would not have permitted Britain or any other nation to excel her in the construction of vessels of iron—knowing as she did of the immense stores of mineral wealth which lay buried in her lap, and which only required a concentration of capital and genius to raise and develop. But it was not to be, such considerations were thrown patriotically aside and Britain seized her opportunity and secured the pre-eminent position until then held by us as a shipowning and shipbuilding nation. As a result our tonnage in foreign trade dwindled down

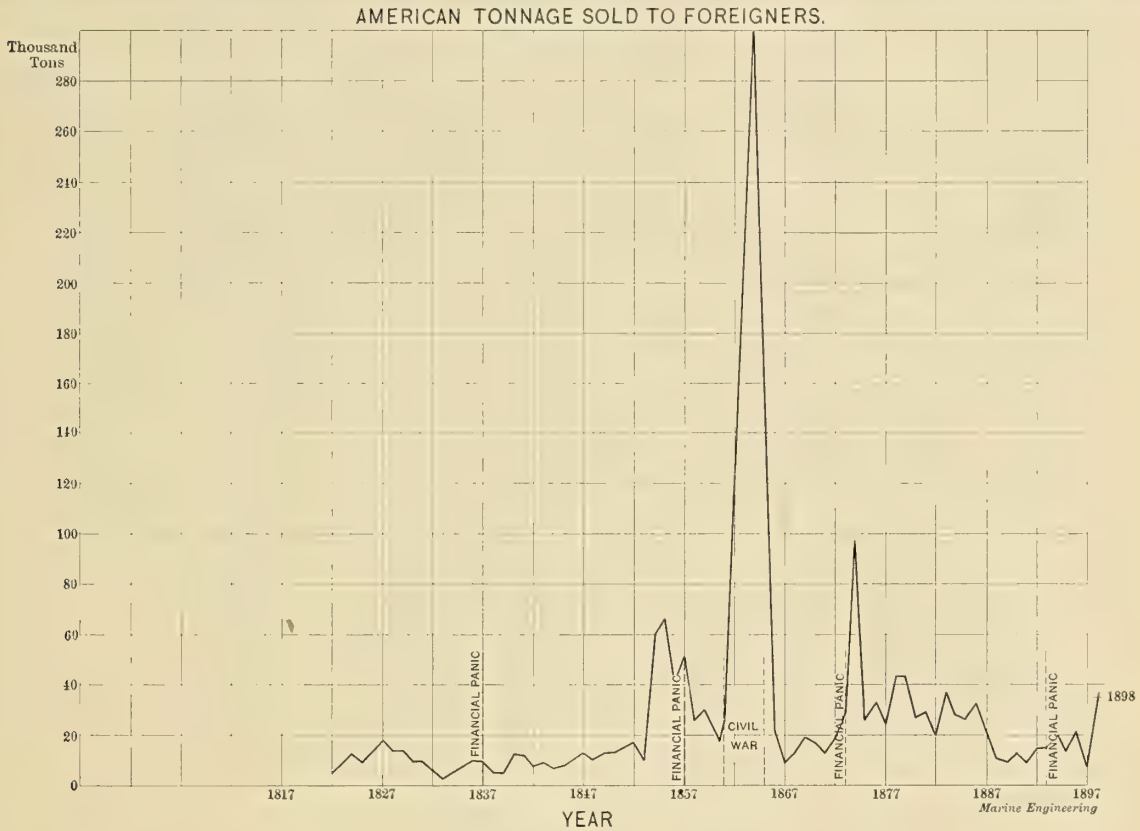


DIAGRAM B.

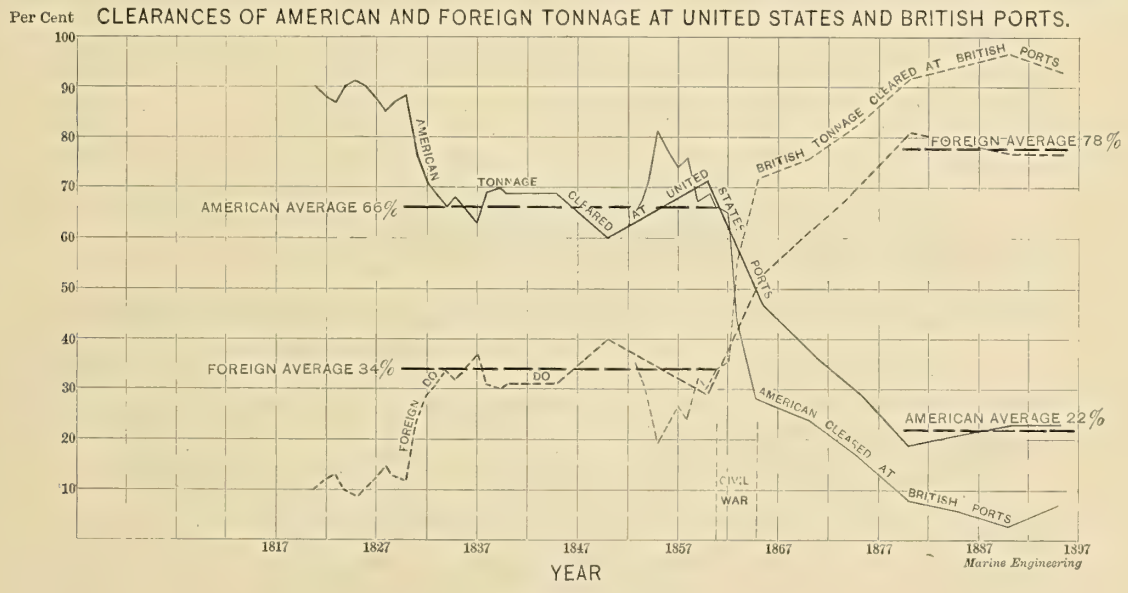


DIAGRAM C.

to 725,200 in 1898, a drop of 1,774,800 tons from the maximum of 2 1-2 million tons.

Diagram *B* is auxiliary to diagram *A*. It shows the amount of American tonnage sold to foreigners year by year during the period 1821-1898. As will be noted on inspection the annual sale from 1821 to 1861—on an average about 12,000 tons per annum—was not greater than might be expected, from an ordinary trading and bartering standpoint; but the sales from 1861 to 1896 tell only too well the story illustrated by diagram *A*. It is interesting to note that if the sales of each year from 1861 to 1896 he added together the total amounts to 1,550,000 tons, which is within 120,000 tons of the difference of 1,670,000 between the maximum and minimum tonnage engaged in foreign trade, already referred to; the discrepancy of 120,000 could probably be accounted for by losses from collisions, wrecks, etc.

Diagram *C* consists of two sets of curves, one set showing the percentage of American and foreign tonnage cleared at American ports, the other set giving the percentage of American and British tonnage cleared at British ports. These curves show in a comparative manner our position, past and present, in the foreign carrying trade; the clearance of American tonnage cleared at American ports being on an average about 66 per cent from 1832 to 1861; from 1861 to 1879 it dropped down to about 22 per cent, and this it has maintained as an average, showing a slight rise at the present time. The clearance of American tonnage at British ports amounted to 66 per cent in 1861; from this it dropped rapidly downwards until, in 1890, it was only 3 per cent, reaching 8 per cent in 1895. As in diagrams *A* and *B* the curves of diagram *C* point conclusively to the civil war as being the primary cause of the decline in the foreign trade.

Turning our attention to the condition of our own coasting trade during the same period, diagram *D* shows the tonnage of American shipping in our coasting trade from 1797 to 1898. Starting at 1797, we find 237,500 tons engaged, increasing at a uniformly rapid rate to an average of about 800,000 tons in 1827-1828; here a sudden drop took place, lasting for a year or so, when we notice the average assuming an upward tendency, once more rising at a phenomenally rapid rate (receiving a slight check during the period of the civil war) until it reached a maximum of 3,380,000 tons in 1865. From that year a decline on the average will be observed, this being probably due to the aftermath of the civil war, emphasized and extended by the financial crisis of 1873. Remaining stationary around an average of 2 3-4 million tons for a year or so, it started, in 1882, to ascend again until, in 1893, we find our total coasting tonnage amounting to 3,854,000 tons. The crisis of 1893 lowered it a trifle in 1894, but it rose again in 1895 and continued on the rise until 1898, when it reached 3,959,702 tons.

A study of this diagram will prove that from the most remote times the development of our coasting

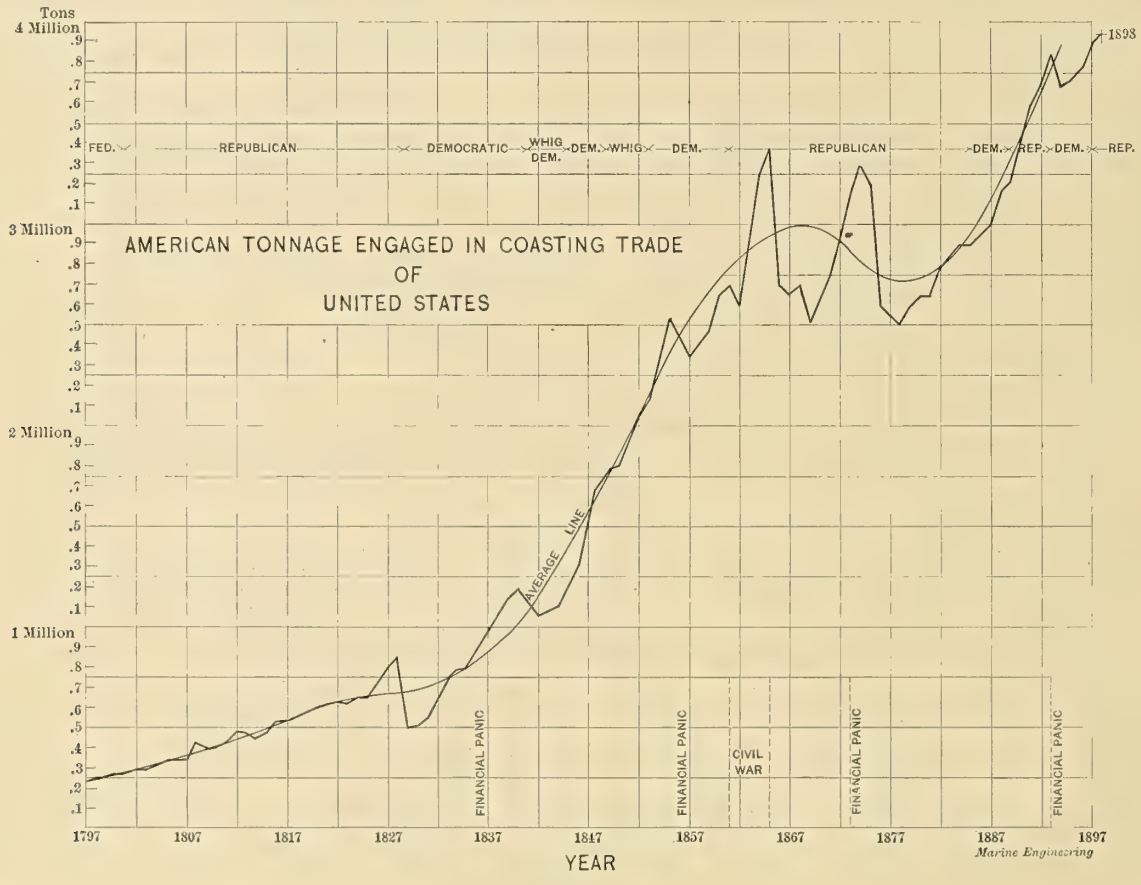


DIAGRAM D.

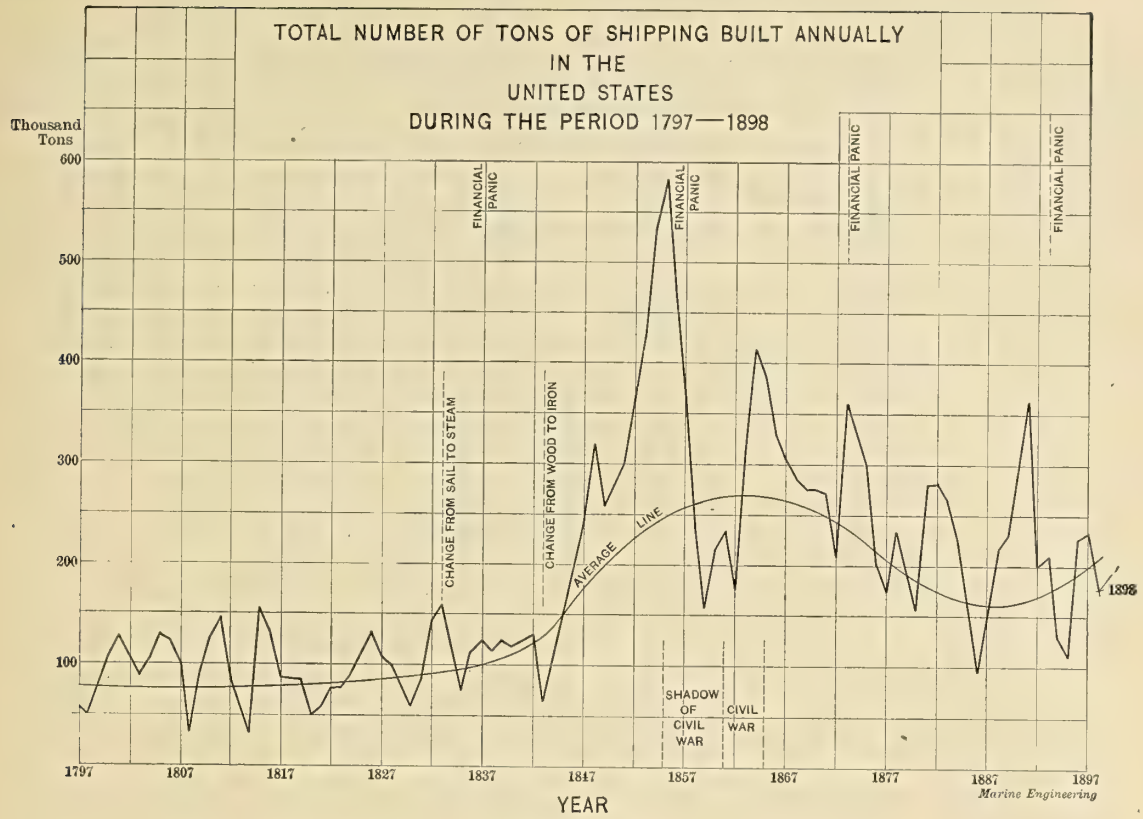


DIAGRAM E.

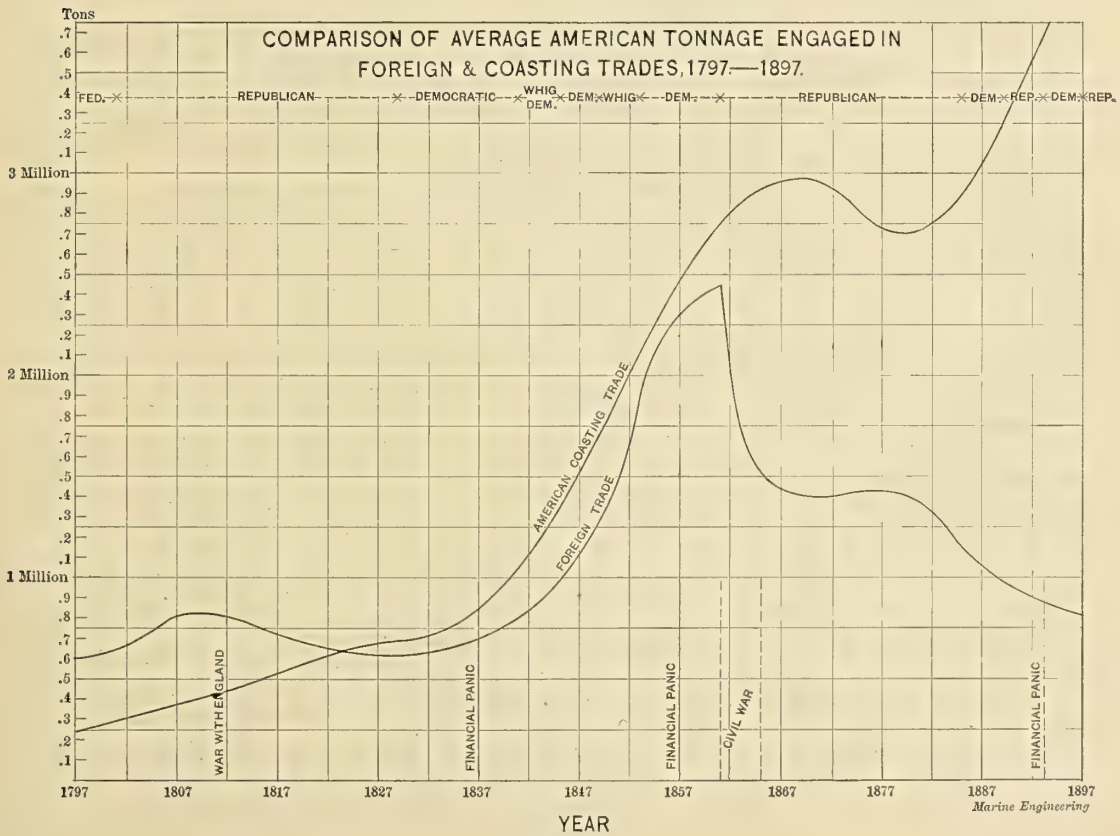


DIAGRAM E$_2$.

marine has been rapid and uniform; even the civil war, comparatively speaking, had little effect on its growth beyond unsteadying it for ten or twelve years, after which it resumed its march of progress and development with full vigor, and it is in this splendid condition that we find it at the present day.

Diagram *E* 2 shows the average curves of diagram *A* and *D*, forming an interesting comparison between the progress of two leading sections of our Mercantile Marine.

We have reveiwed the conditions of our Mercantile Marine, and have learned that our coasting service is on a solid foundation and in a flourishing condition, increasing at a greater rate than at any other time during the past 100 years, and we know that with the enormous development of all branches of industry and commerce, which is in progress throughout the country, that its future is well secured.

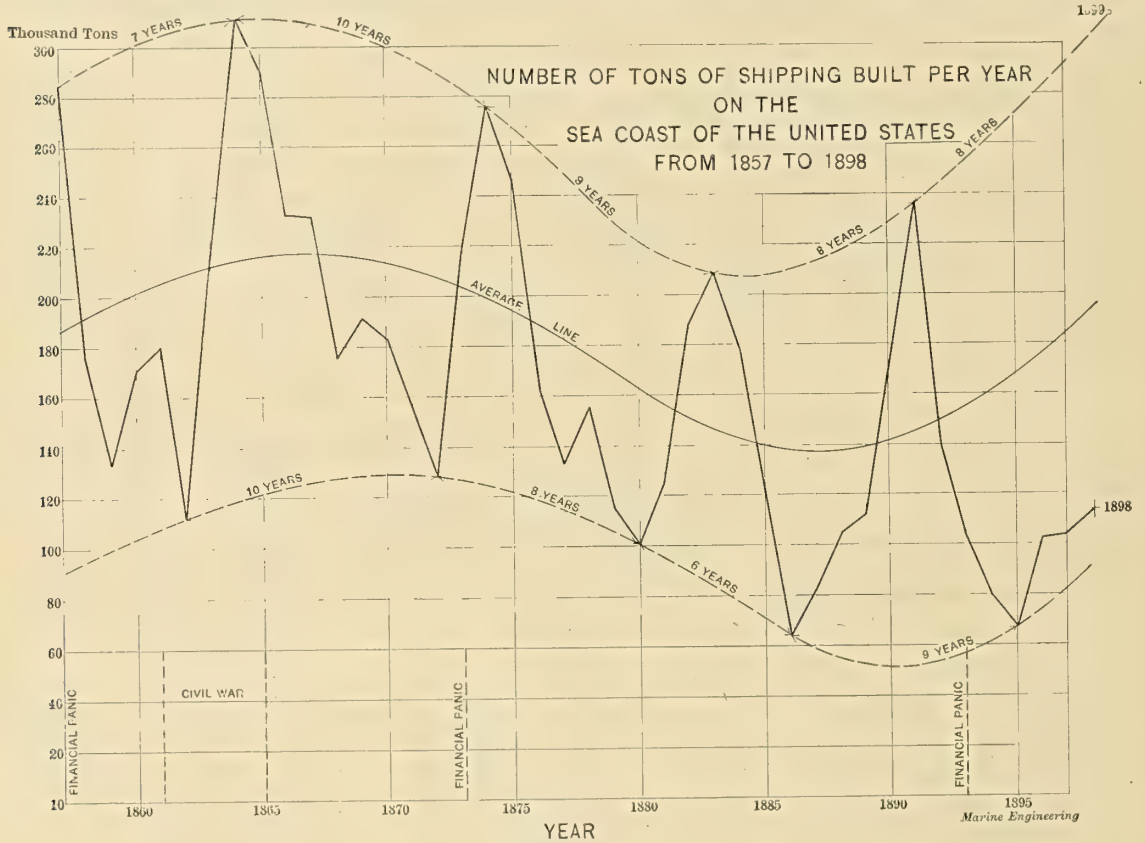


DIAGRAM F.

As to the future of our foreign trading, this is a problem involving consideration far too complex to admit of full discussion here—the subject is largely an experimental one. In the past few years there has been an awakening of general interest in the matter, and various schemes and projects have been evolved looking towards its resuscitation. The main question is: What are the obstacles that stand in the way of its future development? Shipping people answer—impossibility of competing with foreign built and foreign owned vessels, claiming that vessels are built cheaper abroad and that owing to smaller wages and rations the foreign vessels cost less for running expenses. Are these obstacles insuperable? The writer is decidedly of the opinion that with properly organized and efficiently conducted ship and engine building concerns we should be able to produce vessels as cheaply and efficiently as our European rivals—we are doing this already in other engineering activities; why not then in shipbuilding? As to the running expenses of vessels there is no doubt that, in order to overcome this obstacle, shipowners must get assistance by legislation. A discriminating duty bill has been passed, and other schemes for Federal aid are under consideration, but while such measures, if enacted, may help, something more direct in its action and effect must be done. Mail subsidies are all very well in their way, but they benefit only a certain class of vessel, which, after all, is not the backbone of a real commercial marine. Something must be done for the freight steamer to enable it to compete with the cheaper run foreigner, and that something, in the opinion of the writer, must be in the form of tonnage bounties for American built and American owned vessels. With the awakened interest in our shipping matters that is being shown on all hands at the present day, it is to be hoped that legislation in this direction will be passed in the near future, and from the date of passing such measures the ultimate supremacy of the United States as a maritime commercial nation will be undoubtedly assured.

Having in the preceding studied the conditions of shipowning, we will now turn our attention to its twin sister—shipbuilding—in which as a national industry we are primarily interested.

Diagram *E* has been prepared to show the total

number of tons built annually in the United States from 1796 to 1898, inclusive; following the progress of shipbuilding, as indicated by the average line, we note a steady increase right along the march of years from 1797 up to about 1863 or 1864. From this point on there is just as rapid a decline until 1886, when the curve ceases to descend and takes a rapidly ascending path, which it is pursuing at the present time. As we are chiefly interested in the present discussion in the shipbuilding on the coast, diagram *F* shows the building progress on the coast of the United States from 1857 to 1897; it will be observed on inspection that the mean line of building on the coast has the same general characteristics as that shown on diagram *E*, a rapidly increasing tendency to rise being distinctly shown from 1886 and continuing upward at the present time.

The following excerpt from the report of the U. S. Commissioner of Navigation for 1898 bears out in a remarkable degree the opinions of the writer as to the brilliant future in prospect for the commercial marine of the United States:

The additions to the merchant fleet of the United States during the current fiscal year will exceed the increase during any year in our recent history. The year of our greatest construction was 1855, when 2,027 vessels of 583,450 tons were built. Since the civil war our greatest annual output was during 1874, when 2,147 vessels, of 432,725 tons, were built. The largest annual increase of late years was the addition of 1,411 vessels, of 392,658 tons, in 1891. The additions from all sources to our merchant marine for the year ending June 30 (1899), it may be predicted, will amount to nearly 400,000 tons. The outlook for domestic shipbuilding, as indicated, is favorable, and the output of our yards should exceed 250,000 tons. Of the 62,000 tons of domestic merchant shipping purchased by the Government to meet the temporary exigencies of war, a considerable proportion will doubtless soon return to commercial pursuits. Of the foreign shipping directed by Congress in June to be documented, about 20,000 tons were not reported before the close of the fiscal year, and will, accordingly, be included in this year's figures. Vessels condemned as prize during the recent war, and entitled for that reason to American registers, aggregate nearly 20,000 tons, of which nearly all have been or will be documented during the current year. Congress, it is assumed, will provide at an early day, a method for awarding American documents to vessels which before annexation were under the Hawaiian flag. The measures adopted after the Louisiana and Alaska purchases are reproduced in Appendix K (*see Report*). The Hawaiian registered list on August 23, 1898, consisted of 62 vessels, of 31,543 tons. Upon the establishment of permanent American control over the Philippines and Porto Rico measures will be necessary to bestow the American flag on the vessels belonging to those islands. The Philippine merchant fleet consists of 93 vessels, of 19,966 tons, but Porto Rico is practically without home shipping. . . . The addition to our fleet from foreign sources mentioned, with some noteworthy exceptions, almost wholly on the Pacific, will be small vessels, adapted to coasting or interinsular communication. The registration of the complete fleet of Northern Pacific Company and the balance of the fleet of the Pacific Mail Steamship Company, by special acts of Congress, and the transfer to the Pacific coast of four American steamships hitherto engaged in transatlantic trade, indicate preparation on the part of the United States to take the lead in transpacific navigation.

It has been frequently claimed that the change from sail to steam, occurring about 1833, and the change from wood to iron were the leading causes for the decline in American shipbuilding; but, as will be noted on inspection of diagram *E*, the rate of increase in the annual output of new vessels, from the time these changes took place, was greater than the rate of increase previously, up to 1855 (in which year was produced the largest amount of tonnage in the history of the nation, 585,000 tons). As has been shown in the discussion of our shipowning interests, however, in this year the nation began to feel the first real tremblings of the impending civil war, a spirit of uneasiness in financial circles ensued, and from this point the annual output followed the same course of decline as originally shown to have taken place in our shipowning interests. It was not the lack of ability either in providing the proper materials or in the skill of the American artisan that caused the decline in construction of vessels; it was due to circumstances momentous to the nation, and direful to the industry, creating opportunities which were eagerly seized by our British rivals.

Now, from the shipbuilder's standpoint, what are the conditions which exist at the present day?

As has been clearly shown, shipowning interests are distinctly on the increase, both in our foreign and domestic trades, legislation is assured in the immediate future which can have no other effect than that of increasing the rate of progress; the chief materials used in ship construction—steel and iron—are being produced at prices equally as low, and in some cases lower, than in Europe; the machinery used in the manipulation of both the metals and wood is superior and more efficient than that used in the majority of ship and engine building concerns on the other side of the Atlantic, and with the vast mineral resources of the country in the first place, and the world acknowledged ingenuity of the American people in the second, and the determination not to be beaten in the third, the process of cheapening the cost of production cannot fail to go on. It is true that the labor costs more in the United States (probably from 10 per cent to 15 per cent) than in the United Kingdom, but with properly arranged systems and methods of work established the labor bill can be readily reduced. It has been already proved by the construction of the new vessels for our navy that we are able to produce vessels of this class equally good in every respect, and as cheaply as those of foreign nations. The building of freight steamers requires only certain modifications in our systems to be equally successful.

Referring again to diagram *E* a feature will be observed which is common to all activities in engineering industries, that is periodic fluctuations. On inspection we observe maximum points of production; starting at 1857 these occur at intervals of 7, 10, 9, 8, and 6 years—a mean of 8 1-2 years, and minimum production at intervals of 10, 8, 6 and 9 years, an average of 8 1-4 years; from the experience then of the past forty years we may safely predict a maximum production to occur about 1899; we touched the bedrock minimum in 1895 and are unquestionably on the rise.

Summing up the preceding, it may be claimed that our shipping interests are in a rising condition, and the capitalist looking for a solid paying investment need have no hesitation in placing his money in the ship and engine building industries, and, as has been shown, the present time is most opportune, the beginning of flood tide.

FULL POWERED SEA-GOING STEAM YACHT APHRODITE FOR COL. OLIVER H. PAYNE, OF NEW YORK.

BY WILLIAM A. FAIRBURN.

The single screw steel steam yacht *Aphrodite* is the largest and finest steam pleasure craft that American designers and builders have as yet produced. This handsome vessel has been constructed by the Bath Iron Works, of Bath, Me., C. R. Hanscom, general superintendent, for Colonel Oliver H. Payne, of New York. The contract was signed early in January, 1898, and a month later the contractors commenced the erection of a steel-ship shed 312 ft. long and 51 ft. wide, in which to construct the vessel. The keel of the yacht was laid in June, and on the first day of December, the steel hull being then practically completed, she was launched and christened *Aphrodite*, by Miss Vivien Scott, the daughter of the yacht's commander, Captain C. W. Scott, formerly of the steamer yacht *Eleanor*.

The dimensions of the *Aphrodite* are:

Length over all including bowsprit	344 ft.	
" " " hull	302 "	
" L. W. L	260 "	4 in.
Beam molded	35 "	6 "
Depth, side, moulded	21 "	4 "
" center "	22 "	
Normal cruising draft	15 "	
Load draft	16 "	
Displacement	2,000 tons.	
Ratio of length to beam	7.32	
" " " " depth side	12.2	
" " " " " center	11.81	
" " beam to draft normal	2.37	
Gross tonnage Custom House measurement	1,148	
Net " " " "	654	

DETAILS OF CONSTRUCTION.

The steel hull of the vessel is very heavy and rigid, and the scantlings are in excess of the requirements of any classification society. She will receive the highest rating at the American Bureau of Shipping and the United States Standard Association. The yacht has a flat keel instead of the usual side-bar keel. She has good deadrise, a very easy bilge and graceful curving sides, with a moderate tumble home. The displacement is well proportioned, the center of buoyancy being about amidships, with the ends not too fine. She has a drag aft of 9 in., and the forefoot is cut away somewhat so as to decrease the wetted surface and eliminate weight where there is but little buoyancy. The bow lines flare above the load water line so as to make the vessel more comfortable in a head sea. She has a rounding stern, with a medium overhang, and the stern lines are such as warrant good behaviour when running before a heavy sea. The *Aphrodite* is fitted with large bilge keels or rolling chocks. These keels are 24 in. deep and 140 ft. long. They are formed of steel plates filled with white pine, the thickness varying from 9 in. at the ship's side to 1 in. at the outer edge. As the width of these bilge keels is quite large for a vessel of this type, viz., 24 in., and as the area of the two keels is fully one-twelfth of the area the load water plane, they cannot fail to prove very efficient as rolling chocks. No permanent ballast has been fitted in the *Aphrodite*, as the yacht has ample initial stability, but four large water ballast tanks are fitted, two forward and two aft of the machinery spaces, with a total capacity of 100 tons. The displacement of the vessel can thus be increased and the trim regulated at will. The hull of the yacht is divided into eighteen water tight compartments. There are no less than seven water tight athwartship steel bulkheads extending up to the main deck, and two other bulkheads are water tight up to the lower deck. No doors are cut in any of these bulkheads except where absolutely necessary. The passage from the engine room to the fire room is above the water line, and the doors to the shaft alley and the coal bunkers are the only doors in water tight bulkheads placed below the water line.

There are many innovations in the construction of this interesting vessel. The main deck is plated with steel throughout. The continuous strokes of plating amidships are as heavy as the shell plates, and great care has been taken to place the neutral axis of the vessel as near the center of depth as is practicable. A top-gallant forecastle is fitted forward with full head room between it and the main deck. This forms a covering for the windlass, and in it are also located the petty officers' and crews' W. C., washroom and bathroom. The large deck house, 160 ft. in length, is a steel structure of great strength and rigidity, all the metal work being carefully concealed by handsome paneled mahogany. Vertical sliding air ports 20 in. in dia. are fitted in this house. These are more efficient for an ocean going vessel than the usual rectangular windows, and they also tend to give her a much more shipshape appearance. It has been the intention of the owner to secure ample deck room and freedom at sea rather than large rooms in which to entertain. In this respect the *Aphrodite* is an ideal boat for a lover of the sea. On each side of the deck house there is a clear space of about 7 ft., and there is also a large clear quarter deck, from which one can see the whole length of the ship. The top of the deck house runs out to the side of the vessel, forming a shade deck. This forms a most desirable promenade deck, and it also shelters the walk alongside the deck house on the main deck below.

DETAILS OF EQUIPMENT.

The *Aphrodite* is equipped with an excellent steam laundry and steam drying room. She is also fitted with a very complete ice-making plant. Large refrigerating chambers are located in the forward hold divided into three parts for meat, fowl and fish. These rooms are insulated with 1 1-2 in. nonpareil cork, the woodwork being of spruce throughout. In the afterhold there are six large fresh-water tanks, containing 25 tons of water for "domestic" purposes. Sanitary and fresh-water tanks supplying water by gravity are not placed on the upper deck of this vessel, as is the custom in the majority of steam yachts to-day, but a far preferable constant pressure system has been adopted throughout. There are no less than twelve bath rooms aboard this vessel, and seven of them in the owner's and guest quarters have the floor covered with small rubber tiles, and the sides up to the deck overhead covered with 6 in.

extra quality white glazed tiles, fastened with nickel-plated screws and washers. Each bathtub is supplied with hot and cold fresh and sea water. All the bath room fittings are rich, though plain. The lavatories are oval, with rectangular mirrors above, the water closets are fitted with flushometer valves, and all the plumbing and metal work in these rooms are nickel plated. Shower baths instead of tub baths have been provided for the crew forward, and these rooms are tiled and leaded.

The general arrangement of the *Aphrodite* was described in detail in the February, 1898, issue of MARINE ENGINEERING. The style and finish of all the rooms already completed is first class in every respect. There is an absence of carving noticeable, and none of the rooms are profusely decorated, yet, at the same time, everything is very substantial, and

SINGLE SCREW STEAM YACHT APHRODITE, OWNED BY COL. O. H. PAYNE, NEW YORK.

well and artistically arranged, and the quality of the material used is very choice. The officers' quarters forward are finished in cherry and ash, and the captains room with concealed bath and W. C., excellent desk, bureau and furnishings, is a model.

The *Aphrodite's* electric plant is very complete, two direct coupled generating sets (M. P. 4 — 20 — 550) have been fitted, the voltage being 110. The engines are 6 1-2 in. by 5 in., and the steam pressure 80 lbs. A storage battery with sixty-two cells has been fitted by the Electric Storage Battery Co., of Philadelphia, and the accumulators are placed just abaft the engine room bulkhead alongside the shaft alley. Two search lights are fitted at the forward end of the shade deck. A Hyde steam capstan windlass is provided for 1 3-4in. chain, with cylinders 9 in. by 9 in. working at boiler pressure. This windless can be operated from the forecastle deck. A hand capstan is on the main deck aft. The main cables consist of 240 fathoms, of 1 3-4 in. stud link chain and 90 fathoms of 1 in. stream chain is also carried. The two bower anchors are of the "Baldt" stockless type, each weighing 4,000 lbs. The steam anchor weighs 1,350 lbs. excluding the stock, and the kedges weigh 675 lbs. and 335 lbs. respectively. The yacht is fitted with a Williamson steam steering engine, located in the engine room, and a Hyde improved Robinson hand steerer is directly connected to the rudder stock.

The *Aphrodite* carries eight handsome boats: viz., one 30 ft. power launch and one 28 ft. power launch built by the Gas Engine and Power Co., two 28 ft. lifeboats, one 28 ft. gig, one 28 ft. cutter, and two 18 ft. dinghies. A very pleasing sail plan is one of the striking features of the vessel. The bowsprit is of steel about 20 in. dia. and 55 ft. long, all the other spars are of carefully selected Oregon pine, with the exception of a few of the smaller ones, which are of spruce. The fore and main lower masts are about 85 ft. long, and the topmasts are 60 ft. long. The lower yards measure 70 ft. and the spanker gaff is 65 ft. long. The total sail area is approximately 16,000 sq. ft., which means that the yacht has about two-thirds full sail power. All the standing rigging

of the vessel is set up by means of manganese bronze turnbuckles, and the majority of these, including all those connected to the shrouds, are finished bright.

PROPELLING MACHINERY.

The machinery consists of a vertical triple expansion engine with cylinders 28 in., 43 1-4 in. and 70 in. dia., and 38 in. stroke. The engine was designed to indicate 3,200 H.P. at about 132 revolutions. The propeller is a four bladed right hand bronze wheel cast in one piece. The diameter is 12 ft. 7 1-2 in., and the pitch is variable. Steam is supplied by four single-ended steel Scotch boilers at 165 lbs. pressure, working natural draft. They are each 14 ft. 4 in. mean diameter, and 12 ft. long. Each boiler is fitted with three 48 in. corrugated furnaces. The total grate surface of the four boilers is 320 sq. ft., and the total heating surface is 9,500 sq. ft.

SPEED TESTS OF THE APHRODITE.

At 7.30 a. m. Thursday morning, March 9, the *Aphrodite* left the wharf of her builders for her official speed test. The machinery of the yacht had been given frequent dock trials during the preceding month, but this was the first time that the vessel had left the wharf under her own steam. The programme for the day consisted of a progressive trial during her run down the Kennebec to the ocean; turning trials in the deep water beyond Seguin Island; progressive speed tests on the measured mile off Southport in the vicinity of Boothbay Harbor, and a four hour full power acceptance trial at sea. The progressive trial made during the run down the Kennebec river was intended to give approximate results and correct a revolution curve which had been previously prepared.

This trial proved very interesting, and as the method adopted of obtaining the speed is new in our country, although it might be considered as merely the development of an old sailor's method, it may be interesting to explain how the results were obtained. Two stations were selected on the starboard main rail of the yacht, and the distance between these stations by careful measurement was found to be 235 ft. The forward one was located just aft of the topgallant forecastle, and the aft station was on a line with the rudder stock. A plane table was located at each station carefully graduated and set square with the center line of the vessel. These plane tables were made for use in the turning circle trials, and each had an arm about 4 ft. long with a vertical sight at each end. During the progressive trial in the river the arms of these tables were set at 90 deg., and therefore a sight base of 235 ft. was formed. An observer was stationed at each plane table with a stop watch that has been previously rated. Electric bells and a carefully arranged code of signals formed the communication between the stations and the engine room. When all was ready for a test, the engine room was communicated with and the revolutions were decreased or increased to the number specified. The pilot kept the vessel for a few minutes on a straight course, and one of the crew at the forward end of the forecastle deck threw overboard, slightly forward and well clear of the vessel, a block of wood. Each observer had his stop watch set at zero, and as the block of wood passed the sights of the respective plane tables each pressed the stop of his watch. One of the observers then took both watches, and placing one in each hand he stopped them instantaneously, and the difference of the readings of the two watches gave the correct time the ship required to cross the base of 235 ft., and from these figures the correct speed in knots or miles per hour was easily obtained. The revolution at the time the speed observations were taken were then reported from the engine room and one spot on the revolution curve was therefore obtained.

On the trial of the *Aphrodite* the cylinders were not indicated during this test and merely speed and revolutions were noted, as it was the intention at that time to give the vessel a very complete progressive speed test on the measured mile at Southport. The following figures are the results of the four tests made by the method described here, and the total time occupied by making these observations and allowing time for the vessel to attain a uniform rate of speed before each set of observations were taken was only about 20 minutes.

SPEED TRIAL DATA OF STEAM YACHT APHRODITE.

Time.	I. H.P.	Steam.	Rev.	Vacuum.	1 P. Rec.	L. P. Rec.
9.45		155	135	26	42	6
10.	3000	150	132	24½	48	8
10.15		150	135			
10.30	2960	138	131	24½	48	8
10.45		132	128			
11.	2590	125	126	24½	43	6
11.15		122	84			
11.30	2430	155	123	24½	36	5
11.45		162	134			
*12.	3230	152	135	24½	53	7
12.15		135	134			
12.30	2270	120	122	24½	37	6
12.45		122	106			
1.	1470	124	101	24½	23	5
1.15		137	128			
1.30	2780	132	128	24½	47	6
1.45		155				

*M. E. P. referred to L. P. Cylinder = 32.55 lbs.

TIME BETWEEN SIGHTS.	SPEED IN KTS. PER HOUR.	REV. PER MIN.
11.75 sec.	11.84	104
17.25 "	8.07	72
21 "	6.63	58
24.75 "	5.62	52

As the floating blocks of wood and the ship are always subject to the same currents, etc., all tidal influences are eliminated by this method.

Upon arriving off Seguin it was found that the weather conditions, whilst quite favorable at that time, did not look very promising, and as the builders were quite confident that the yacht would easily make the required contract speed of 15 knots, it was decided to run the 4 hours sea trial first, and the progressive trial afterwards if the weather remained favorable. The course was from Seguin light with Pond Island light and Mile Ledge buoy in line over to Wood Island light with Old Orchard House and buoy in line a distance of 28 1-2 nautical miles. The depth of water on this course varies from 15 to 40 fathoms, the average being about 25 fathoms. At 9-45-20 o'clock, the *Aphrodite* went over the line. The steam pressure was 155 lbs., and the engine was turning about 135 revolutions per minute. The wild steering of the quartermaster during the first fifteen minutes considerably handicapped the vessel. Although two Sturtevant blowers with 30 inch suctions were fitted on board the yacht, to ventilate all the living spaces and fire room, these were not used to assist the draft during the speed trial. Neither was the draft assisted by the steam jet in the stack, and the trial was in every sense of the word a natural draft trial. The run to Halfway Rock was made at an average rate of speed of 16.7 knots. After passing this point some trouble was caused by the splitting of four condenser tubes, and the revolutions had to be reduced from 130 to about 80. This accident, throughout the remainder of the trial, necessitated the use of some sea water as feed to the boilers, and slight trouble was frequently experienced by a high water level in two of the boilers owing to lack of care in regulating the feed. The end of the course was reached 11-35-20 o'clock, and in spite of a slow down of about 20 minutes and unsatisfactory steering the 28 1-2 nautical miles were covered in 1 hour and 50 minutes, equivalent to a mean speed of 15.5 knots.

The return trip was commenced at 11-46-35 o'clock, and with 152 lbs. steam pressure and 135 revolutions. The first part of the course was covered at a speed of 16.9 knots, and then the vessel had to slow down owing to the advent of a northeast snowstorm; the thick weather making it extremely dangerous to steam at full speed. The compasses had not been adjusted, and as no land was visible, although the vessel was within two or three miles of the shore, the engines were stopped at 1-32 o'clock. The tow boat *Adela* was sighted about this time, and the *Aphrodite* following the tug, seguin rock was located about half a mile distant on the starboard side amidship at 1-40 o'clock. It was found that on the return run 29 1-2 nautical miles had been covered in 1 hour 54 minutes, including all slow downs and stops, which is equivalent to a mean speed of 15.53 knots. The average rate of speed of the yacht, excluding the slow downs and stop, was 16.8 knots, and the average speed throughout the run, including all slow downs and the stop was 15.54 knots, a remarkable performance.

A few days after the official speed trials the *Aphrodite* steamed to New York, where she is at present receiving some of the joiner work for the owner's quarters, which has been constructed by Messrs. Davenport of Boston, the builders of the main cabin of the steam yacht *Eleanor*. The yacht will be cemented and finished in New York, as the Bath Iron Works could not guarantee a satisfactory smooth exterior if the cementing had been done at the works early in March. The *Aphrodite* with her large sail spread and powerful machinery is probably at present the fastest ocean pleasure cruiser afloat. She will be able to steam 16 knots day after day, and her bunkers will carry sufficient coal to allow her to cross the Atlantic at a speed of 15 knots. The *Aphrodite* when she goes into commission will have cost Col. Oliver H. Payne about $450,000, and the running expenses of the yacht will be about $10,000 per month.

VIBRATIONS OF STEAMSHIPS AND METHODS OF BALANCING MARINE ENGINES—V.

BY C. H. PEABODY, B. Sc.

(Last Installment.)

In the statement of the kinds of vibrations that may occur in a ship, attention was called to vibrations of higher orders, with several loops and nodes. The simplest vibrations, with two nodes and one loop, have properly received the most attention, as they are the most troublesome; these may be considered to be vibrations of the first order. Vibrations of the first order are caused either by unbalanced engines at or near the middle of the ship or by engines which are not in running balance at or near a node. It has been said that engines which are in standing balance will give little trouble when placed near the middle of a ship, because the rocking couples have little influence at a loop. But vibrations of the second order have two loops and three nodes, one of which is at the middle of the ship. Consequently an engine which is not in running balance may set up vibrations of the second order when placed at the middle of a ship. Again the loops of vibrations of the second order are not very far from the nodes of vibrations of the first order. It may, therefore, be found that an unbalanced engine which has been considered to be unobnoxious when placed near the node of vibrations of the first order, may set up vibrations of the second order if it chances to come at a loop for that order of vibrations. Finally vibrations of the third order have four nodes and three loops. An unbalanced engine at any one of these three loops may set up vibrations of that order, or an engine in standing, but not in running, balance may set up vibrations if set near any one of the four nodes. It seems then that an unbalanced engine set anywhere in a ship may set up vibrations of some order. But since vibrations of the higher order are much more rapid and much less troublesome, they are less likely to occur, and when they do occur require less attention.

For sake of simplicity it has been considered that an engine will set up vibrations only when its number of revolutions is the same as the number of vibrations of the hull of the ship. But it is sufficient that the number of revolutions shall be some multiple or some submultiple of the number of vibrations. That is, vibrations may occur when the revolutions of the engine are half or are twice the number of vibrations. For example, Mr. Yarrow found that a torpedo boat vibrated violently at 200, 400, 600 and

800 revolutions of the engine, while there was little or no vibration when the engine ran at 300, 500 or 700 revolutions per minute. The most dangerous vibrations, however, are found when there is a coincidence of the number of revolutions and vibrations and when the vibrations are of the first order. There have, however, been some instances of very annoying vibrations caused by small high-speed engines; thus one of the United States cruisers had a vertical electric lighting engine placed directly on the protective deck forward. The vibrations resulting were so disagreeable, especially in the officers' quarters, that the engine was removed.

If an engine causes vibrations in a ship when running at a certain speed, then as the engine is speeded up and approaches the time of natural vibration of the hull, the ship begins to tremble at regular intervals, coming to rest between those intervals. The reason for this is that the interval between two fluctuations of the unbalanced force which tends to shake the ship is then only a little longer than the interval between the successive vibrations of the ship. The close approach to coincidence enables the force to set up a vibration which at first increases in violence, because several successive fluctuations can act so as to increase the movements of the hull. But presently the time of application of the force lags so far behind the time of the vibrations that it begins to oppose the motion it has itself provoked, and then it tends to quiet the ship. Since there is seldom an exact coincidence of the time of rotation and the time of oscillation, the shaking due to the engines of a ship usually runs through a series of phases, increasing in violence and then becoming quieter. If the ship has twin screws the shaking is further affected by the lack of exact equality of speed of the two engines. When the engines happen to run together the shaking is very violent, but as one engine gains on its mate the effects of the two engines may be so opposed as to partially neutralize each other.

The purpose of the engines of a screw ship is to turn the propeller at a uniform speed. The twist applied by the engine to the screw shaft must be resisted by the hull, and the hull is consequently twisted, though to an imperceptible extent. But the turning effort of the engine is not uniform and the fluctuations of this effort tend to set up twisting vibrations of the hull. These vibrations are noticeable only on very slender hulls, as of torpedo boats and torpedo-boat destroyers. These torsional vibrations have nodes and loops, and may be of the first, second or third order. These vibrations are most noticeable in single-screw boats, for twin-screw engines turning in opposite directions tend to neutralize each other's influence. Schlick says that the arrangement of the cranks of a three-crank engine has little effect on the amount of torsional vibrations, but that the changing of the number of cranks, for example, replacing a three-crank engine by a four-crank engine, may entirely do away with the vibrations because there are then four instead of three fluctuations of turning effort per revolution.

The question now occurs as to what shall be done if a ship shows excessive vibrations when the engine is running. Having determined that the vibrations are proper vibrations of the structure of the hull and are not local vibrations due to lack of local strength or stiffness, it appears that the only remedy is to change the time of revolution of the engine or to change the time of vibration of the hull. It is supposed, of course, that all proper methods have previously been used for balancing the engine either during the design or as a result of experience in running the engine.

Now the time of the engine is the easiest to change, provided that either a slower speed of the ship can be accepted or that the desired speed can be attained with a slower rotation of the engine. To get a slower speed of the engine of a screw ship it is sufficient to increase the pitch of the propeller either by twisting the blades (if they are bolted to the hub) or by making a new wheel (if solid). But in general the engine cannot develop the required power if the revolutions are reduced, so that this method will commonly be impossible. It is true that the same effect can be attained by increasing the speed of the engine by decreasing the pitch of the propeller, but there is then this objection that the ship is sure to tremble violently at some speed less than the full speed, and must always pass through a period of vibration before full speed is attained. And again if for any cause the full speed cannot be attained it will be necessary to reduce the speed below that at which the vibrations occur. Few merchant ships have engines that run so fast as to pass beyond the speed at which vibrations occur, but several cruisers show vibrations when running at something less than full speed, and it is not unusual to find one or more speeds for a torpedo boat at which the vibrations are more troublesome than at full speed.

If the speed of the engine cannot be changed enough to reduce the vibration of the hull, then we must attempt to increase the number of vibrations of the hull by adding new members to the framing of the ship or by strengthening those already in place. It must be borne in mind, however, that additional stiffness rather than additional strength is to be sought, though the method of gaining stiffness is usually to add strength. Of course, it may be possible to reduce the number of vibrations by reducing the stiffness of the hull, but this is objectionable for the same reason that we do not like to increase the speed of the engine, to say nothing of the fact that dangerous vibrations are most common in lightly built ships which it would be dangerous to weaken.

In working out the design for a ship which is to have powerful and high-speed engines so that vibrations may be expected, it is well to calculate the probable time of vibrations of the hull by the equation already given, namely

$$N = C\sqrt{\frac{I}{DL^3}}$$

Of the terms that occur in this equation the length and displacement for a new ship will, of course, be known after the design is well advanced. The moment of inertia is then also determined in connection with calculations of strength. The constant C is not

so well known as could be desired; much more experimentation is required to determine this quantity. We may, however, use the equation to estimate the probability of trouble from vibration by aid of the equation when C is not known. Suppose that we have a ship of a given type which does not show much vibration at full speed nor at reduced speeds, so that we are sure that the revolutions of the engine per minute are less than the natural vibrations of the ship. If we use the revolutions of the engine R in place of N in the foregoing equation, together with the length displacement and moment of inertia of the midship section, we may calculate a trial value of

$$C=\frac{R}{\sqrt{\frac{I}{DL^3}}}$$

Taking I^1, D^1 and L^1 from the design of the new ship, we may find

$$R^1=C\sqrt{\frac{I^1}{D^1L^3}}$$

which will be a probably safe number of revolutions for the new ship.

Roughly we may consider that the displacement of a ship is proportional to the length and that the moment of inertia is proportional to the fourth power of the depth, which in turn may be considered to be proportional to the length. This makes the number of vibrations of the hull proportional to the length of the ship. This rough method can be used only when the new ship is really an enlarged copy of the existing ship with like proportions.

Somewhat elaborate instruments have been devised by Yarrow and by Schlick for measuring and recording the vibrations of ships. They consist essentially of a heavy weight hung on a long spring so that the natural vibration of the weight on the spring is very slow. The weight is consequently little affected by the rapid vibrations of the ship's hull and remains practically at rest. The frame which supports this suspended weight carries a paper drum which is driven by clock work. A pencil on the suspended weight presses against this paper, and when there are no vibrations draws a straight line. When this instrument is placed at the node of a vibrating ship, the paper, being on the frame, moves up and down with the ship, while the pencil on the suspended weight is at rest. The consequence is that the pencil draws a wavy line on the paper, which indicates at once the extent and the number of vibrations of the hull, since the paper on the drum is drawn along at a known uniform rate by clockwork. If the instrument is moved from place to place the nodes and loops may be located. A modification of this instrument is used to investigate horizontal vibrations. A very simple device, like a weight at the end of a long piece of india rubber, supported by a simple frame or even held in the hand, may be used to locate nodes, and if vibrations are not too rapid may be used to count the number of vibrations per minute, remembering that it is easier to count double vibrations. It would appear, however, well worth while to make careful investigations of vibrations of ships with proper instruments and competent observers.

Warrant Machinists in U. S. Navy.

A circular has been issued by the Navy Department giving information regarding the appointment of warrant machinists, which reads as follows:

NAVY DEPARTMENT,
WASHINGTON, D. C.

REGULATIONS FOR THE APPOINTMENT OF WARRANT MACHINISTS.

In pursuance of the fourteenth and fifteenth sections of an act passed at the third session of the Fifty-fifth Congress, approved March 3, 1899, entitled "An act to reorganize and increase the efficiency of the personnel of the Navy and Marine Corps of the United States," applications will be received by the Navy Department for the appointment of warrant machinists.

2. By the terms of the act, the examination preliminary to appointment is open, first, to all machinists by trade, of good record in the naval service, and if a sufficient number of machinists from the Navy are not found duly qualified, then any machinists of good character, not above thirty years of age, in civil life shall be eligible for such examination and appointment to fill the remaining vacancies. The Navy Department will, therefore, first conduct an examination of candidates selected from machinists of the Navy only. Later, if a sufficient number to fill the one hundred positions authorized by the act fail to qualify, another examination, open to machinists in civil life, will be held.

3. Applications for naval machinists must be made to the Secretary of the Navy, to the commander-in-chief of a fleet or commandant of a station, and forwarded through the official channels prescribed by the U. S. Navy Regulations. No person will be examined who is not a citizen of the United States.

4. With each application there must be, either in the form of endorsements attached to the application or of separate letters, statements of opinion from the commanding officer and the engineer officer under whom the candidate is serving at the time of making his application. These opinions will be limited to the question of whether or not the applicant is regarded as qualified for the position of warrant machinist and worthy of such advancement. Similar letters or endorsements must be obtained by the candidate, wherever practicable, from commanding officers and engineers with whom he has formerly served. The conduct and efficiency reports on file in the Navy Department will also be consulted in making up the candidate's record. All candidates will be required to pass a satisfactory examination before a board of naval surgeons as to their physical fitness for the service. Medical records of the candidate may also be consulted by the examining board in cases where other qualifications appear equal.

5. The candidate must be able to write a legible hand and have sufficient knowledge of arithmetic to enable him to keep the engine room log-book, and an account of stores when necessary. His ability to write English will be judged from examination papers in other subjects. The examination in arithmetic will be limited to the addition, subtraction, multiplication and division of whole numbers, and of vul-

gar and decimal fractions; the reduction of common fractions to decimals; proportion or the rule of three and in the mensuration of surfaces and solids of the regular forms.

6. In engineering the candidate must be able to describe the types of marine engines and boilers, and their attachments, now in common use; the manner of putting them in operation, and the precautions to be taken to guard against the derangements to which they are liable. He must show himself familiar with the uses, operation and construction of the various auxiliary machines now in use on board ships of war; such as air and circulating pumps, feed pumps, fire and bilge pumps, wrecking pumps, hydraulic pumps, forced draft and ventilating blowers, dynamo engines, evaporators, distillers, ice machines, starting and turning engines, anchor engines, steering engines, boat and deck winches, launch machinery, ash hoists, etc. He must be familiar with the materials of which the different parts of machinery, steam pumps particularly, should be made, and he must be able to describe the repairs and remedies usually adopted on board ship in cases of derangement or breakage to parts of main and auxiliary machinery, He must be a practical steam fitter and capable of making joints in high-pressure hydralic piping. He must be familiar with the manner of taking indicator cards from steam engines and must be able to interpret and work out such cards. He must be able to read drawings, make working sketches, and lay out work.

7. The examination shall be competitive, and the time when it is to be held will be designated by the Navy Department. A series of questions covering the subjects above enumerated will be prepared and sent to all ships and naval stations of the United States where enlisted mechanics are on duty. Using these questions, and no others, written examinations of candidates shall be held under the supervision of an officer or officers designated for the purpose by the senior officer present. All candidates on any ship or at any section shall be examined the same day and at the same time. Communication between candidates during examination shall not be allowed, and either giving or receiving assistance shall at once disqualify the offender as a candidate. The examination papers, together with testimonials and all other records, in each case, shall be forwarded to the Navy Department, where the board, provided for in Sec. 14 of the act, shall mark the papers and grade the successful candidates in their order of merit as shown by the final averages.

8. Examination papers shall be marked on the basis of 1,000 as perfect. The following weights will be assigned to the different subjects:

Naval record	100
Recommendations of commanding officers	200
Recommendations of engineer officers	200
Handwriting	30
Arithmetic	70
Marine engines	100
Marine boilers	100
Auxiliary machinery	100
Indicators and diagrams	50
Working sketches	50
	1,000

JOHN D. LONG, Secretary.

AMERICAN SCHOOLS OF MARINE ENGINEERING AND NAVAL ARCHITECTURE.

COURSES PROVIDED FOR IN THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, BOSTON, MASS.

Description of a Great Modern Technical School Adequately Equipped for Scientific Work—Details of the Courses of Study, the Laboratory Facilities and the Student Life and Surroundings.

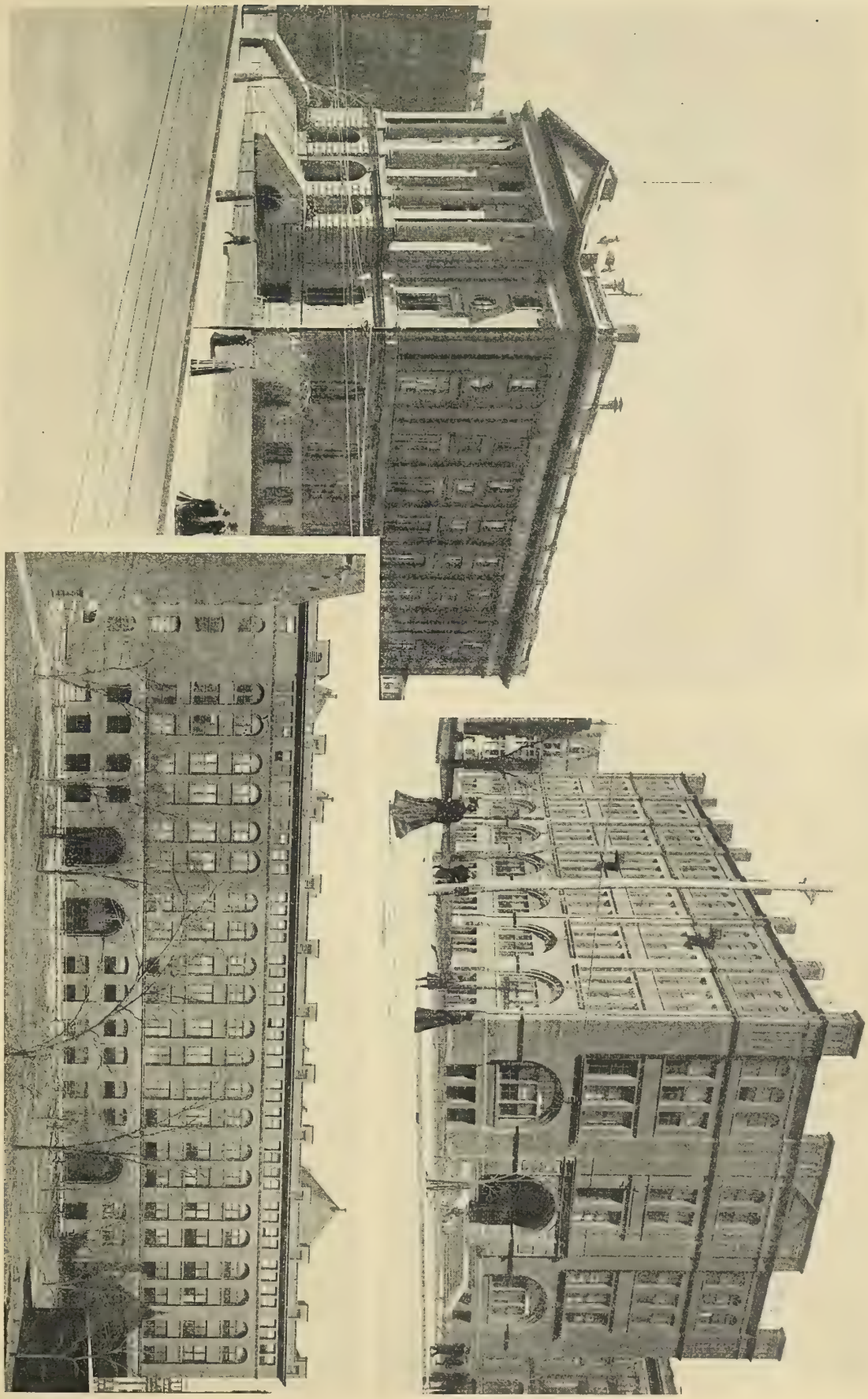
An adequate conception of the purpose, scope and methods of instruction of the course in naval architecture and marine engineering of the Massachusetts Institute of Technology can be obtained only by a consideration of the establishment and development of the Institute as a whole. As the Institute is to a large degree the child of its founder and first president, the late Professor William S. Rogers, his life and personality must be the starting point for any intelligent discussion of this famous technical school. President Rogers was born in Philadelphia in 1804 and was reared in an atmosphere of scholarship, for his father was a professor of the College of William and Mary, and here he commenced his career as a teacher and scientist. In time he became a professor in the University of Virginia, which in its disregard of the old traditions in education was a fit precursor of the Institute—so far removed in locality and so different in many of its aims and methods, but entirely alike in its devotion to truth and sound scholarship.

The original proposition for an institute of technology at Boston sprang from a course of lectures before the Lowell Institute delivered in 1844 by Professor Henry Rogers, a younger brother, to whom Professor William Rogers wrote the following characteristic sentence:

"The true and only practicable object of a polytechnic school is, as I consider, the teaching, not the manipulations and minute details of the arts, which can be done only in the workshop, but the inculcation of all the scientific principles which form the basis and explanation of them."

This and Professor Rogers' early advocacy and persistent support of laboratories of chemistry, physics and engineering can be taken as the foundation of the methods of the Massachusetts Institute of Technology. That the methods have been successful is evident from the reputation of the school and the success of its alumni in wide and varied fields of influence.

The corporation of the Massachusetts Institute of Technology, consisting of a group of prominent men of Boston, with Professor Rogers as president, was organized in 1861; on account of the civil war, however, the regular course of instruction was not opened until 1865. This corporation, of which the president of the institute is a member, owns and manages the property of the Institute, appoints the president, pro-



Rogers Building.

Pierce Building.

Walker Building.

PRINCIPAL BUILDINGS OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, BOSTON, MASSACHUSETTS.

fessors and other officers and instructors and grants degrees on the recommendation of the faculty. The facutly establishes and controls the courses of instruction and discipline of the school.

The buildings of the Institute, a familiar sight to Bostonians, are located near Copley Square, in the more modern portion of the city of Boston. They are partly on land granted by the State, and partly on adjacent property purchased at later periods. Not far away are the classical Public Library, the Museum of Fine Arts and the Museum of Natural History, thus forming a center of art, science and enlightenment in a city long noted for its literary and intellectual activities. At first all the departments were contained in the parent building, now called after its founder, Rogers Building; afterward, as the needs of the school increased, the building alongside, known as Walker Building, was occupied, and since the continued growth has necessitated constant expansion until now there are in all seven buildings containing departments of the Institute.

COURSES OF INSTRUCTION.

At the beginning the Institute offered courses in Civil and Mechanical Engineering, Mining Engineering and a course in Literature and Science. Now the Institute offers thirteen distinct courses in Civil, Mechanical, Mining, Electrical, Chemical and Sanitary Engineering and Naval Architecture, in Chemistry, Physics, Geology, Biology, Architecture and general studies, and many of these courses offer options that allow students to develop special branches of their intended profession. The school now has on its rolls about twelve hundred students, who are instructed by fifty-four professors and more than one hundred lecturers, instructors and assistants. This large teaching force is required by the divisions and subdivisions of classes, in the numerous subjects and specialties which make up the courses of instruction, and more especially by the extensive introduction of laboratory methods which have from the first been very highly developed.

The courses may be grouped as the Engineering Course, including the first seven enumerated, and the course in Pure Science, such as Chemistry, Physics, etc.; also Architecture, which has so large an artistic side, and the General Course, which includes literary, economic and similar studies. All these courses have in common a substantial basis of Mathematics, Pure Science, Language and Literature to give a well-rounded general training. Each course, or group of courses, has its further development of Mathematics, Science or Literature along advanced lines as may be required. Students of the largest group, which comprises the engineering courses, while they begin to differentiate at the second year of the course, have a large amount of work in common, including such subjects as Descriptive Geometry, Mechanism, Applied Mechanics, Hydraulic and Steam Engineering. It is held that the engineering student must first of all learn engineering and afterwards add to his knowledge the specialties of the particular branch which he may elect (one of which is Naval Architecture), for the Naval Architect is an Engineer who knows how to build ships.

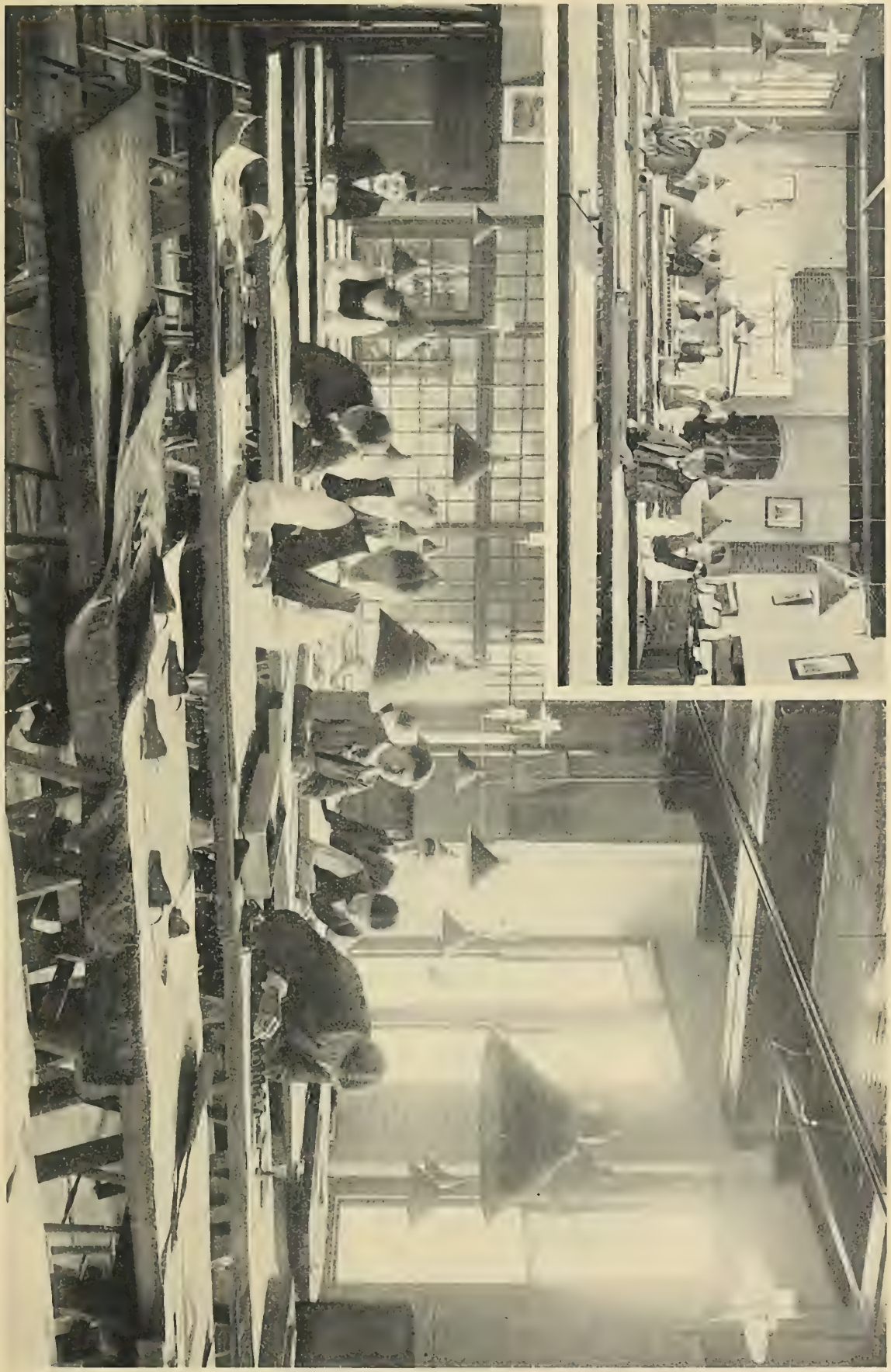
COURSE IN NAVAL ARCHITECTURE.

The inception of the course in Naval Architecture commenced in 1888 from a suggestion by General Walker, during whose presidency the phenomenal growth of the school occurred, that students who took the marine option of Mechanical Engineering ought to know something of the structure and properties of the ship in which are found the marine engines that form the specialty of that option. From this beginning the instruction in Naval Architecture was broadened and was intensified rapidly yet with a conservative adherence to the methods and traditions of the Institute, till, in 1894, it was found possible to offer a complete four years' course covering all the accepted theory of the profession, together with methods of calculation and draughting required for the design of a ship. The department has thus far graduated twenty-six men, of whom twenty or more are in active practice of their profession, and of the small remnant all are in parallel branches of engineering or else have taken up some business from choice. In addition there are a number of graduates who took the undeveloped or embryotic course and have since perfected themselves in their chosen profession, in which they hold positions of responsibility.

Coming now to the course in Naval Architecture in detail: Admission, as to all the courses, is by examination in Algebra, Geometry, History, English and French or German. It is the intention of the authorities that sufficient preparation may be attained in a good high school. A clear admission to any recognized college authorized to grant degrees is taken in lieu of an examination. Students coming from abroad are in general admitted without examination, it being expected that such candidates will inform themselves as to the requirements and satisfy themselves that their general preparation is adequate. Advanced standing may be taken by students, who show that they are competent to take up subjects regularly placed in the higher years.

The course extends over four years; each year beginning the last week in September and ending the first week in June. A recess of ten days is taken after the semi-annual examinations and brief recesses are allowed at Thanksgiving, Christmas and in the month of April. The school year therefore occupies thirty-four weeks, with two examination periods of nearly two weeks each. But so far as appears advisable the progress of students in earlier classes is judged from daily work, with comparatively few examinations.

Instruction is imparted by recitations, lectures, drawing, laboratory and shop work, or by a combination of several of these methods. Many text and reference books have been published by the professors, with special regard to the needs of the school, and there is a large development of printed matter prepared for the use of classes at the Institute only, which is not published; in fact it is the policy to print lecture notes as soon as they take permanent form. The large classes in many subjects allow frequent



SENIORS OF NAVAL ARCHITECTURE AT WORK IN THE DRAUGHTING ROOM, MARINE DEPARTMENT, MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

revision of such notes, without excessive expense to the students. Notes which have not yet assumed even a semi-permanent form, or which are used only by a small number of the students are duplicated by the mimeograph or some similar process. A sample of these is shown in the engraving. The greater portion of the instruction, indeed, in Naval Architecture is given in mimeograph notes, which have been found very convenient, as changes can be made whenever necessary by the addition or ready substitution of sheets.

The Drawing Room work is arranged to illustrate the theoretical work of the lectures and recitations and is carried on so far as possible at the same time.

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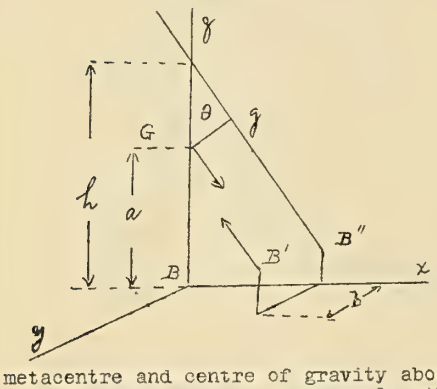
Fig. 50.



metacentre and centre of gravity above the centre of buoyancy B, we may resolve the entire righting moment into two moments

$$D\,(h - a)\sin\theta$$

in the plane of inclination
and

$$D\,b$$

which acts about an axis in that plane. The second moment is small for ordinary inclinations of well formed ships, and is usually ignored in the discussion of stability. When desired the longitudinal position of the centre of buoyancy can be found by taking moments about a transverse axis, as in the calculation for the displacement and centre of buoyancy, in the erect position. When the position of B' after inclination, has been located the value B'B" = b Fig. 50, is readily determined and also the moment of the couple D b. In Barnes' method of

SAMPLE OF MIMEOGRAPH NOTES.

In the same way exercises in the laboratories of engineering and applied mechanics are made to enforce the teachings of engineering principles, and reciprocally the lectures are directed to enable the student to undertake various laboratory problems and investigations intelligently. Practice in the Drawing Room, the Laboratory or the Work Shop is so graduated that the first work assigned to a student is well within his capacity, and he is expected and required to do good work from the first. As he gains power more and more is expected of him, each exercise being intended to require his best efforts and to presuppose all the previous instruction to be at his command. This system yields results of the highest quality and finally enables the instructor to demand a large quantity of work without distressing his students. The thesis which completes the course is left almost entirely to the student, who seeks advice and guidance only so far as may be required to avoid unnecessary waste of effort through inexperience.

LABORATORIES AND WORKSHOPS.

The laboratories in the buildings in Trinity Place occupy a floor space of 21,000 sq. ft. The Testing Laboratory is equipped with a number of machines, ranging in size from an 800,000-pound Emery machine downwards, for making tests of the metals, timber, cement, rope, wire, cloth and masonry. The largest machine will take in a compression specimen 18 ft. long and a tension specimen 12 ft. long.

The Hydraulic Laboratory contains several tanks and standpipes, together with a great variety of connections, for ascertaining the loss of head, laws of discharge, velocity of jets, flow in pipes and for weighing the water in experimental work. There is here also a 48 in. Pelton wheel, a Venturi meter and various weirs, meters, pumps, turbines and rams.

In the Steam Laboratory there is a multiple-expansion engine of the Corliss type, with cylinders 9 in., 16 in. and 24 in. dia. and 30 in. stroke, which can be disconnected so as to run simple, compound or triple. There is additional a tandem compound high-speed engine of 250 horse power. These engines are fully equipped with condensing apparatus, and all other paraphernalia necessary for the most exact determinations. Smaller steam and gas engines are used for instruction in valve setting and methods of construction. The minor apparatus includes a great variety of condensers, pumps, injectors, calorimeters, mercurial pressure and vacuum columns, indicators and other measuring instruments.

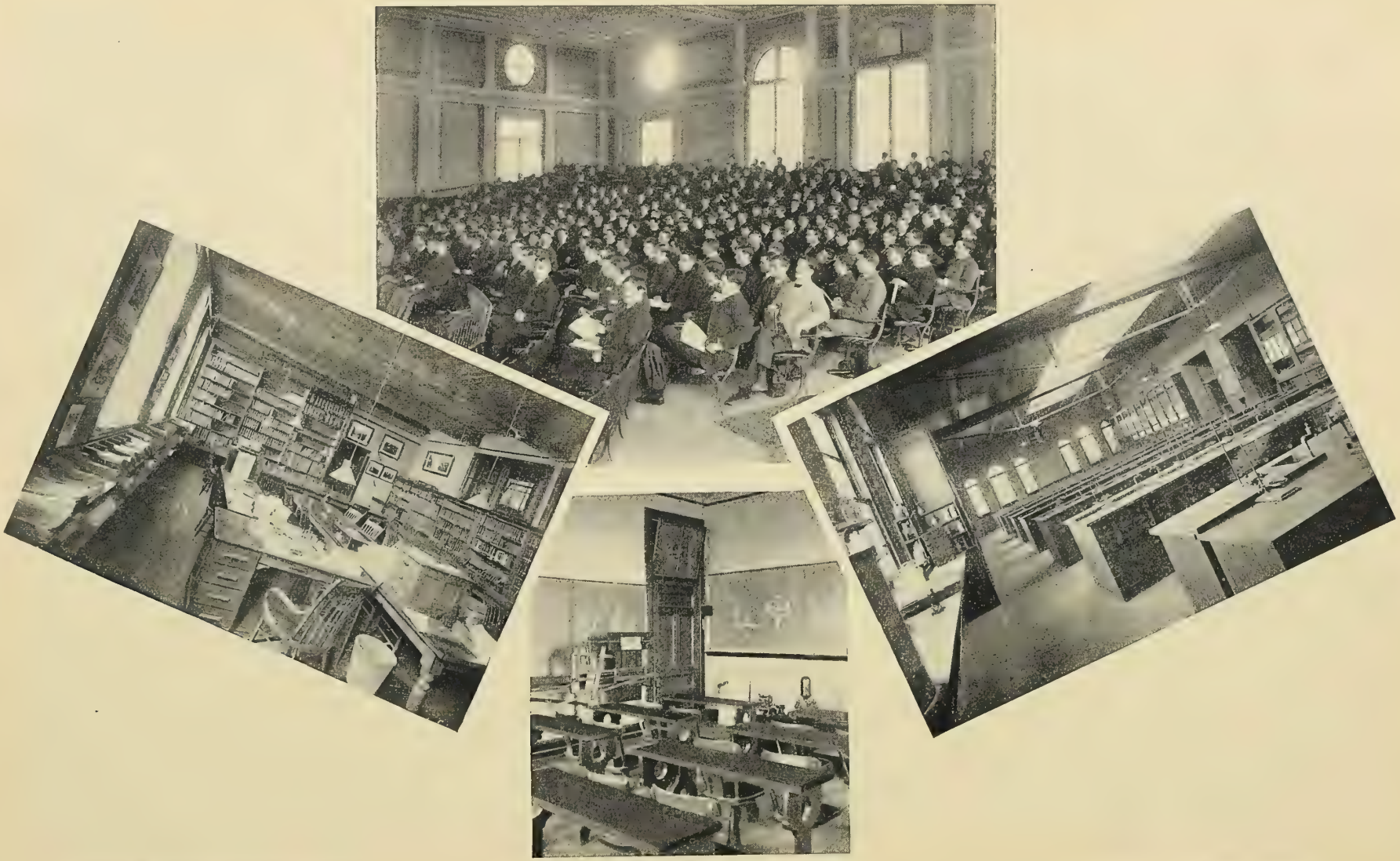
In the laboratories there is also special equipment for experimental work in friction and lubrication, and in the adjacent power house there is a large battery of boilers continually under steam, so arranged as to be available for tests.

The Electrical and Chemical Laboratories are very extensive and contain an immense variety of machines, instruments and apparatus for instruction and special experimentation.

The workshops include: Machine shop, containing twenty-three engine lathes and other machine tools, and also large vice bench space; carpentry, wood turning and pattern making departments, with forty carpenters' benches, buzz, jig and swing saws and other wood working machinery, thirty-six wood lathes, and as many pattern makers' benches; foundry, with cupola, brass furnaces and thirty-two moulders' benches; forge shop, containing thirty-two forges and necessary hammers and drills.

ADVANTAGES OF LOCATION.

Much in the same line is the advantage of the location of the school at an important seaport where vessels of all classes are constantly found at the whaves. Not only that students may find illustrations of the subjects discussed in the lectures and recitation rooms, but that each as he runs across a difficulty in design of a ship or her engines may see for himself how the same or a similar difficulty has been surmounted in a special case. A student who has gone by himself to find how details of design have been



Interior of Special Engineering Library.

Class Attending Lecture in Huntington Hall.
Recitation Room, "Naval Architecture" Course.

First Year Chemical Laboratory.

INTERIOR VIEWS IN VARIOUS BUILDINGS OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

worked out not only learns that detail as he cannot from any lecture, text book, or drawing, but has gained what is worth more than all his books, notes and designs, the power to observe and learn for himself. From an instructive point of view also visits to ships which have met with mishaps and come into port with boilers or engines broken or injured are very valuable; for more can often be learned from mistakes or misfortunes than from success. Even a trip down the harbor in the engine room or a steam vessel is not without its value from the zest it gives to the text book discussion of machinery details.

The work constantly in progress at the Boston Navy Yard and in the large marine workshops in the vicinity is of special value in this connection. By the consent of the Navy Department students have for several years been given practice in laying down ships in the mould loft at the Navy Yard.

SUBDIVISION OF STUDIES IN NAVAL ARCHITECTURE.

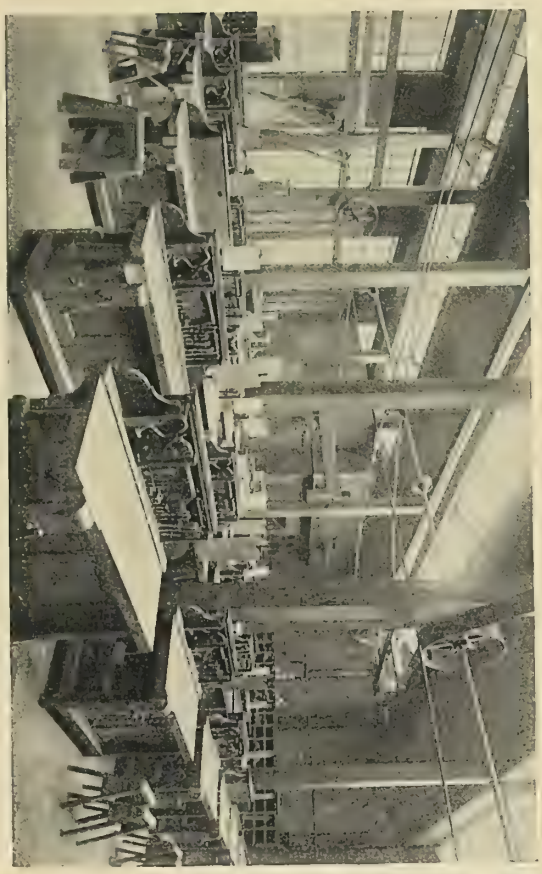
The two first years of the course in Naval Architecture are but little differentiated from the work of the other engineering courses, and lay the foundation in Mathematics, Chemistry and Physics, on which all applied science must rest. The training in common with other such courses is continued in Applied Mechanics and Steam Engineering throughout the third and fourth year. So broad and sound is this training for the engineer at the Institute that many subjects such as the Theory of Integrators, Calculation of Strength, etc., can be either assumed to be familiar to the student when he reaches the specialization in Naval Architecture or may be dismissed after a very brief discussion of their application to ship building. Thus the lecture on Stress and Strains on ships take up only the question of Buoyancy in quiet waters and among waves, and the special devices for facilitating calculations for a ship. It has been found possible, therefore, by a continuous course of two lectures a week throughout the third and fourth years to give adequate discussion of all the accepted theory of the profession, including the General Geometry of Floating Bodies; Statical and Dynamical Stability, with special application to added loads; Carrying Liquids; Bilging Compartments; Launching and Docking; Calculation of Stresses; Rolling in Quiet Water and Among Waves; the General Theory of Waves; the General Problems of Propulsion, including the Influence of Waves made by a ship at high speed; the different Methods of Propelling, by paddle wheels, screw propellors and by sails; Steering and Manœuvering of a Ship Under Steam and Under Sail; Methods of Ventilation, and Adjustments of Compasses. There is given at the same time a sufficient description of methods of construction to enable the student to understand the work which he may see in progress in shipyards and elsewhere, and to intelligently apply the principles of design to a ship. More than this the college does not consider it desirable to undertake, believing that the student must finish his education in the shipyard and the drawing office.

The Drawing Room work is carried on simultaneously with two or three exercises a week throughout the third and fourth years of the course. Beginning with Drawing and Fairing Lines of Ships or Yachts, students make the usual calculations for Displacement, Strength and Stability, and finally make a fairly Complete Design of some special ship, from preference a ship of medium size, large enough to call for all the real problems of a design, but without the multiplicity of detail that might make real design impossible. This department has a fine outfit of Integrators and Calculating Instruments, and machines to facilitate the work of calculation and to familiarize the student with the tools of his profession.

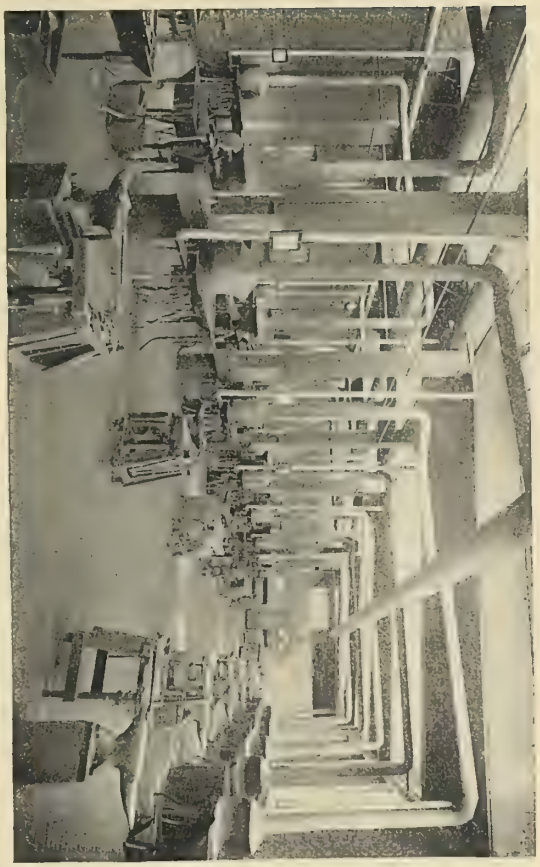
Parallel with this work in Naval Architecture is the work in Steam Engineering, taken by all engineering students, and the work in Marine Engineering, which is taken also by such students in mechanical engineering as may choose that branch for an option. It is considered here that the best co-ordination of the design of the hull and machinery of a ship is one made under the final control of a master of both sides of his profession. Contrary to a commonly accepted idea that there is any essential difference between the construction of the hull and the machinery, the college holds that the work is essentially similar and that no one can completely understand one branch without knowing the other. Whatever separation in practice may be found convenient, it is held to be necessary to carry on instruction in both marine engineering and naval architecture at the same time. In the Marine Engineering course a study is made of the Details of Engine Construction, of Stresses in Engines when running both from steam pressure and from the accelerations of the moving parts, together with a study of the Screw Propeller, of Paddle Wheels and of Hydraulic Propulsion. The students lay out and carry well forward the designs of a marine engine and apply to it the constructions and calculations discussed in the lectures. Students in Naval Architecture practically design, in this connection, the engines for the ship they design in their special instruction in hull work.

GENERAL EDUCATION OF STUDENTS.

Thus far attention has been given mainly to the work of the students, which is directly in or which bears directly on their own profession. But the Institute does not forget that the bulk of the students must get at the same time their general education which shall fit them to meet other educated men on a level. In one sense a sound engineering education is in itself a liberal education, as it teaches how to observe and learn, but it is recognized that without considerable attention to the "humanities" a student of engineering is liable to have a narrow view. Consequently a course in French and German, in History, Literature and Political Economy is carried through the first three years of the college work. And in the study of languages the end sought is not only to open modern languages to the reader of technical literature, but also and mainly that training in the use of language (including English) that can be best attained by a rigid study of a foreign tongue. The proximity of the Institute to the Boston Public Library (to which students have access) and to other

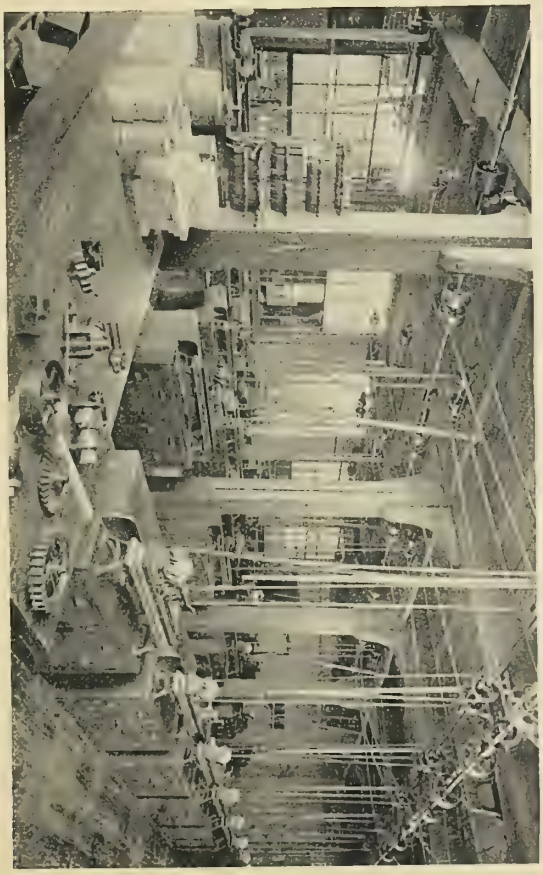


Looking Down Forge Shop.

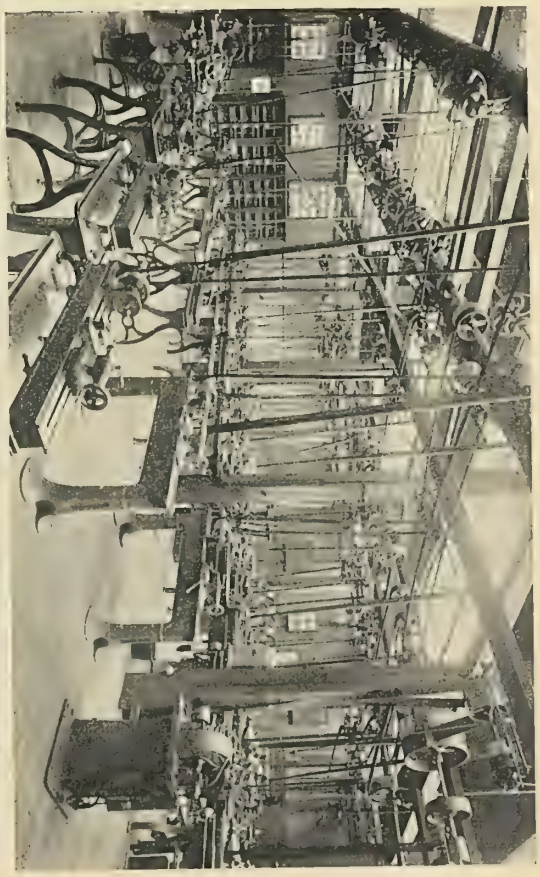


Carpentry and Joinery Shop.

VARIOUS STUDENTS' WORKSHOPS AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY.



General View of Machine Shop.



Lathes in Pattern Shop.

general and scientific libraries in the city afford opportunities for individual research, which are particularly valuable during the preparation of the graduation thesis. The libraries of the institute are working libraries conveniently located near the drawing room or other local habitats of students and are now very complete, each in its own line. Each library has well-kept files of technical periodicals, of which the students make good use. These are particularly valuable in clothing the framework of the regular instruction of the course of study with the records of the life of whatever branch of the profession the student is studying. There is also a large, comfortable and convenient library in the Central Building, which is open at all times, evenings as well as day times, so that no student may lack a light, warm and cheerful place in which to work and read.

STUDENT SOCIAL LIFE.

In the foregoing reiteration of the methods of work, of the requirements of hard and unremitting attention, might lead to the belief that the life of the Institute student was made up of drudging, which in the end would break down all but the gifted. Such is not the case, however, for the amount of time that may be exacted is strictly regulated not to exceed eight hours a day for six days in the week; or the work may be arranged by the student to take half a holiday on Saturday or an occasional evening, as he may desire. The arrangement of studies on alternate days or at longer intervals permits of much flexibility of work. It is true that only a fraction of each entering class persists till graduation, as is evident when there are twelve hundred students in regular attendance, and about two hundred graduated each year, but the loss of any class which takes place mainly at the end of the first year is due in part to inadequate preparation and more largely to a failure of many young men or their friends to comprehend what a technical education is, and whether he has any liking or aptitude for such work. When all is said it must be admitted that life at a technical school is bare and dreary to a young man who does not enjoy his work; the continual grind of distasteful work that is necessary to stay in the classes at all usually eliminates those who have mistaken their calling at the end of a year, and two years finds the classes compact and well drilled as a regular army that is accustomed to working together. In the work itself there is much pleasure and companionship of the best kind for those who can and will bring themselves to a level where the work is a pleasure. Especially is such companionship developed in the latter years, when each in his own chosen specialty meets, daily, and works with congenial fellow students, who understand and share his trials, aims and ambitions. Friendships thus formed in the classes of the Institute have endured the trial of time, and the class associations are maintained and the years are marked off by annual dinners and other functions. Then there are societies of men in the same course, as the Architectural, Biological, and the Civil Engineering and Electrical Engineering Societies and others. Thus far students of the course in Naval Architecture appear to have found the daily association in lecture room and drawing room sufficiently society in itself and there has been no lack of *esprit du corps*. Societies of men from the same city or localities have been maintained for many years, such as the Southern Club and the Chicago Club, etc. Bicycle, canoe and yacht clubs, glee clubs, mandolin and banjo clubs also flourish. Every year the associations for the study of French, German and literature give some theatrical or other form of entertainment. There are many local societies, and also chapters of fraternities, etc. Last, but not least, there is the Young Men's Christian Association, which has a society house where meetings are held.

The students maintain a weekly paper during term time called "The Tech," and the junior class publishes an annual called "Technique." The Institute publishes the "Technology Quarterly," containing articles read before the Society of Arts, and productions of Technology men of all sorts. Then there is the "Technology Review," published by the alumni.

The Technology Club is composed of persons from the corporation, faculty, alumni and senior class. It has a club room conveniently near, where "smoke talks" and other entertainments are held, as well as many class dinners and other reunions.

There are usually thirty or forty young women on the Institute rolls. Many are pursuing specialties to fit them for teaching, to enlarge their usefulness as teachers. Every year there are a few women graduates from the courses in architecture, biology, physics, or chemistry. The young women have a society of their own and a suite of rooms especially fitted up for them.

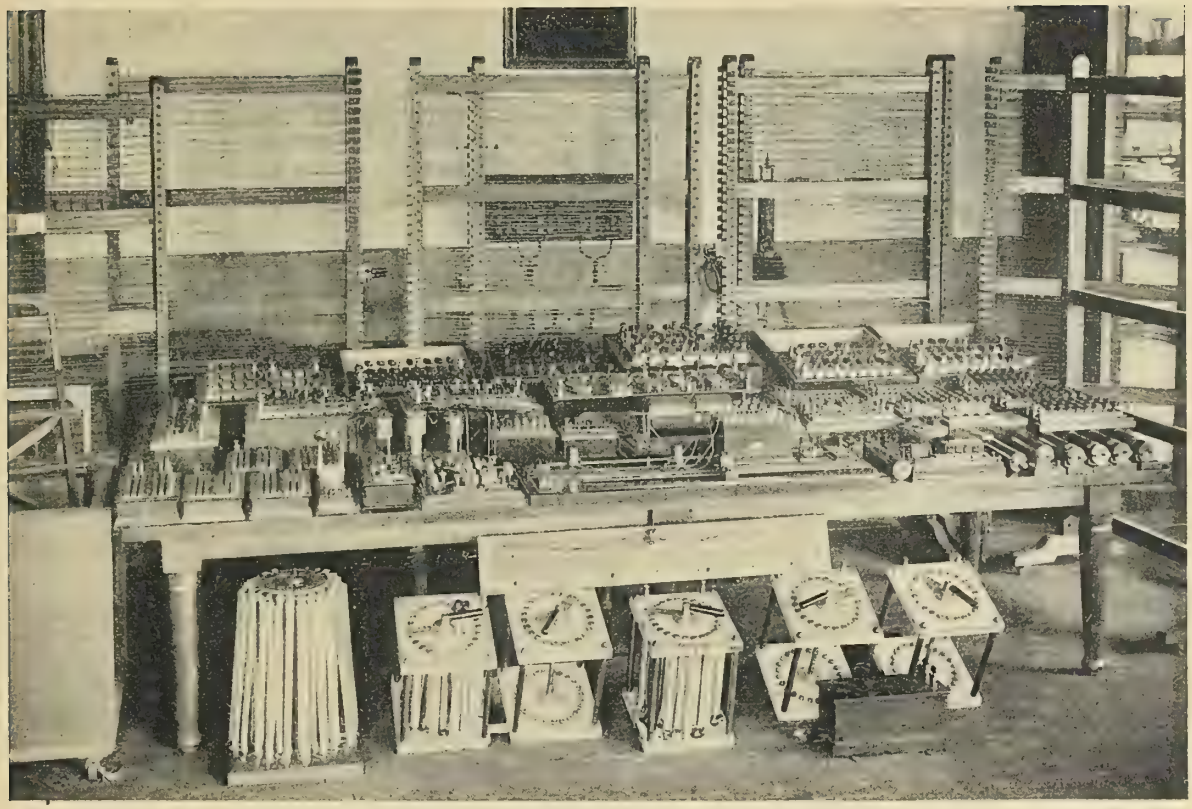
The Institute has a gymnasium, which affords facilities for all kinds of exercise, with baths, etc., and many students make use of the gymnasiums in the vicinity, such as the Boston Young Men's Christian Association gymnasium. From the fact that the majority of the students are seriously in earnest, and on account of serious interruptions that even a few days' absence may make in technical work, the Technology, Athletic, Football and Base Ball Teams have seldom appeared to good advantage. But in track athletics and other lines where individual effort tells the Institute has had a gratifying success.

EXPENSES COVERING TUITION, ETC.

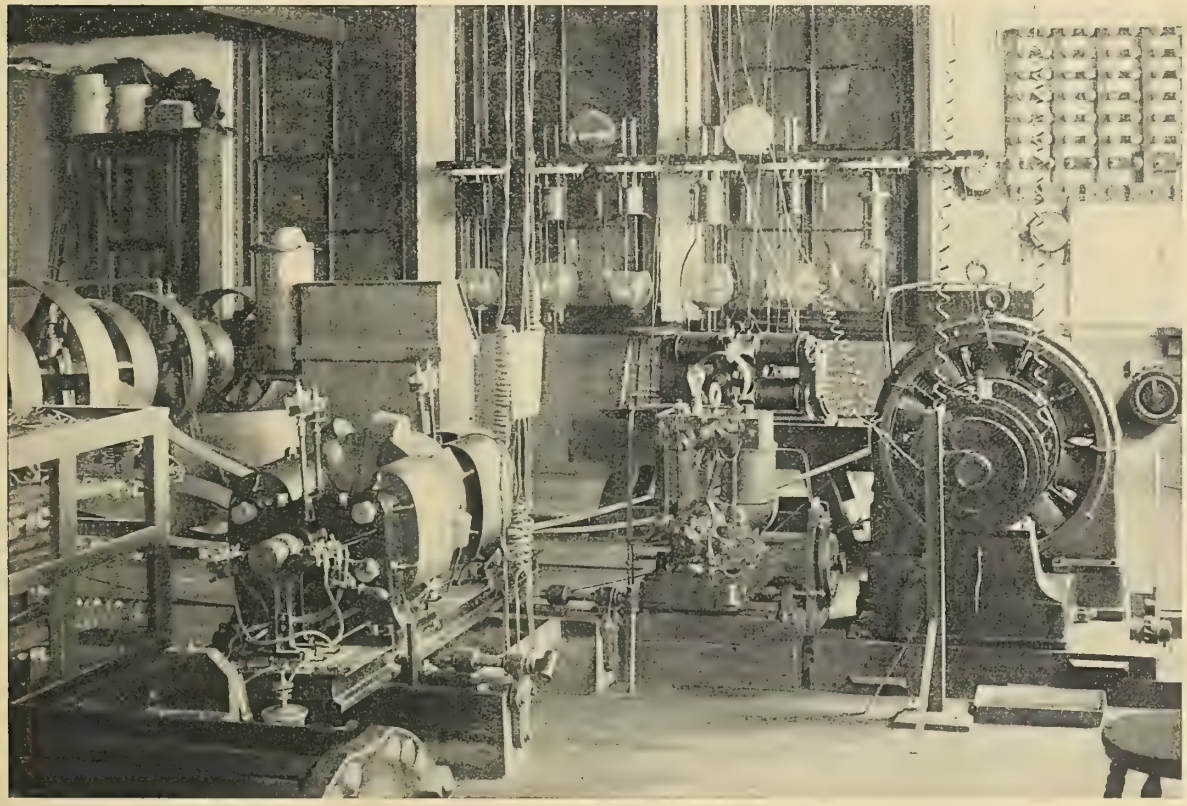
The tuition fee for regular students at the Institute is $200 a year, payable in advance. Special students in general pay the full fee, but under certain circumstances a reduction is made. There are a number of scholarships open to students. Each student on entering the school is required to file a bond for $200 with the Bursar, as security for the payment of all charges against him. The cost of books, drawing instruments, paper and other necessaries averages $30 a year.

Outside of the school expenses, the cost of board and lodging for a student, in the city or suburbs of Boston, need not exceed $7 or $8 a week.

The Institute has no dormitories and does not attempt to control students out of school hours. Many naturally live at home, and others find convenient boarding places near at hand. Some societies have chapter houses where their members may reside. The



ASSEMBLAGE OF RESISTANCE COILS IN THE ELECTRICAL DEPARTMENT.



SPECIAL ELECTRICAL LABORATORY FOR EXPERIMENTAL PURPOSES.

advisability of such a residence depends naturally upon the individual and on the tone of the society.

STUDENT BODY AND FACULTY.

The Institute is a Massachusetts or even a Boston institution, and naturally draws a large proportion of its students from the city and its suburbs, and the majority is always resident in the State, but students are drawn from all the States and Territories, and many come from foreign countries, including the United Kingdom, Canada, South America, Turkey and Japan. The minimum age of admission is set at seventeen years (nearest birthday), but the average age of admission is eighteen. Even when a young man is prepared at an early age he seldom is sufficiently mature earlier to get the full benefit from a technical course.

Since the first class was graduated in 1868 and the earlier classes were all small, the bulk of the alumni is as yet composed of comparatively young men, with their fortunes to make. As a rule an institute graduate may expect immediate employment at living wages, and may make for himself as large a plane as he can occupy. Young men in their impatient natures usually forget that few men attain and fewer can carry large responsibilitity before they are thirty or thirty-five years old.

The course in Naval Architecture is in charge of Prof. C. H. Peabody, who was graduated in 1877, was made a member of the faculty in 1884 and has since developed the work in Steam Engineering, Marine Engineering and Naval Architecture at the Institute. He is the author of "The Thermodynamics of the Steam Engine," of "Tables of the Properties of Saturated Steam," of "Valvegears for the Steam Engine," and (with Professor Miller) of "Steam Boilers."

The faculty is composed with few exceptions (among whom are Dr. Runkle, one of the founders of the school) of men in the prime of life; a considerable proportion, especially among the younger professors, are graduates of the school, whose training has been broadened by foreign travel and study, by experience in practice and by service as teachers. The prominent qualities (as with all technical men) are a capacity for work, an enthusiasm in that work and an absolute loyalty to the school and the work which forbids cliques and shirking. The faculty includes such men as Professor Richards, formerly President of the Society of Mining Engineers; Professor Cross, an acknowledged authority on electricity, especially the telephone; Professor Lanza, whose tests on timber and other investigations on strength of material have formed the basis of much of the modern practices of engineers; Professor Swain, a member of the Subway Commission, and Professor Dewey economist and statistician. The Institute has been specially fortunate in its presidents, beginning with Professor Rogers, who was followed by Dr. Runkle, one of the founders, and later by General Francis A. Walker, who was known as a soldier, economist and educator, and now by Professor Crafts, known by all chemists for his original investigations, and who, aside from these special scientific achievements, has a wonderful grasp of the work and needs of the many and various lines of technical instruction and investigation carried on at the Institute.

AN ACCOUNT OF THE MARCONI SYSTEM OF WIRELESS TELEGRAPHY.

BY CECIL P. POOLE, E. E.

The widespread interest created in marine circles by Signor Marconi's developments in wireless, or rather etherical, telegraphy, is due, of course, to the need for some system of communication between offshore points and the mainland which shall be simpler, more reliable, more flexible and less easily disarranged by extraneous influences than is the existing submarine cable and its apparatus. The application of Marconi's system within the limits of this special field of work is undoubtedly important and its advantages many. The wild claims of unlimited possibilities, however, made for Marconi's system by irresponsible publications are absurd and quite in keeping with the usual newspaper prophecies concerning scientific developments. Controlling ships at a distance, signaling across the Atlantic, displacing the land lines and similar impractical feats have been included as within the alleged scope of space telegraphy. A moment's consideration of the underlying principle of the system will suffice to expose the fallacy of such hasty prognostications.

If an electric current be sent through a wire, mag-

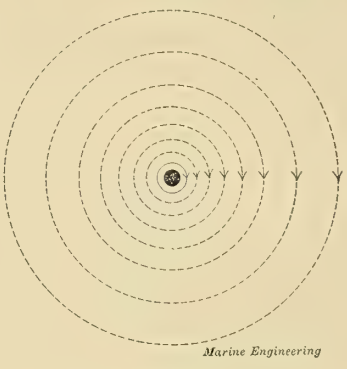


FIG. 1.

netic lines of force are set up concentric to the wire, as indicated by Fig. 1. These lines have no specific limit, but the lines farthest from the wire are weaker than those near it because their path is longer. With a steady current the lines remain unchanged, but with a varying current the circles enlarge and contract as the current increases and decreases. If an alternating current be sent through the wire, the magnetic circles expand and contract with each impulse of current, reversing their direction around the wire (not their projection into space) with each reversal of the current flowing in it. Now, if another wire be set up parallel with the current-carrying wire, an electromotive force, alternating in polarity, will be induced in it by the expansion and contraction of the magnetic circles set up around the first wire, the magnetic lines or waves impinging upon the second wire or being "cut" by it. This is roughly what happens in the Marconi system.

A vertical wire is supplied with rapidly recurring charges of electricity by an induction coil, and correspondingly rapid magnetic oscillations are set up which progress into space perpendicularly to the ver-

tical wire, or substantially so. These waves or oscillations impinge upon a distant vertical wire and induce a current flow in it. The current is so feeble, however, and the oscillations are so rapid that ordinary apparatus will not respond to the induced current, hence a device known as a coherer is used for this purpose.

A closed circuit is not employed at either end, because equal lengths of the circuit would be substantially parallel and the waves propagated in each would almost entirely neutralize those in the other. Instead, the vertical wire is charged electrostatically (condenser fashion), the relief of the electrical stress between the upper end of the wire and the earth being crudely represented in Fig. 2 by lines streaming between the two extremes. The induction coil and other apparatus are located as at *A*. The magnetic circles

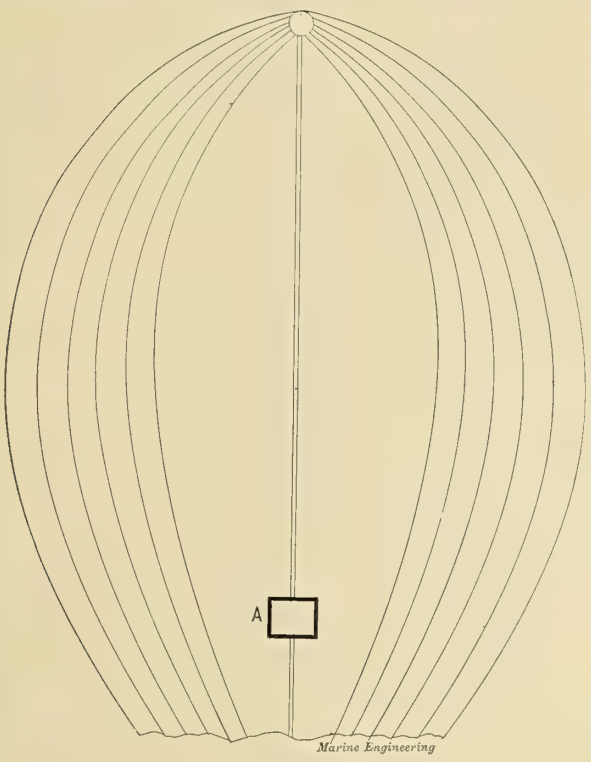


FIG. 2.

or waves may be considered as being created in planes or "layers" at right angles to the "sending wire," or projecting out into space in straight lines from the points of propagation. These waves, lines, or whatever one chooses to call them, are susceptible to reflection, somewhat like light rays, and, consequently, are liable to disturbance or deflection by intervening bright surfaces. Their magnetic character renders them also liable to disturbance by large intervening masses connected with the earth, such as iron buildings, mountains, etc.

Moreover, they are obviously not possessed of volition and cannot turn corners, climb hills, skip along the surface of the earth or sea, or perform any similar antics which they would need to do to possess the wonderful attributes ascribed to them in many quarters. It is plain, from the foregoing, that the transmission of signals by these waves is limited by topographical and physical conditions to a certain degree; if an obstruction, such as a hill or the curvature of the earth, intervene between the points of communication, the vertical wires at each end must be of such a height as to afford an unobstructed path between a considerable length of their upper portions. Hence the impossibility of signaling across the ocean with the present system.

Another drawback to the system thus far is the general accessibility of the transmitted waves. Any receiving station within the radius of range will be affected by the signals, unless a reflector be used at the transmitter and a similar one at the receiver. But where reflectors are used the vertical conductors necessary to long-distance signaling are eliminated, so that privacy is secured only at the sacrifice of the principal *desideratum*, linear range of action.

Notwithstanding the inability thus far to combine the two most desirable features, the system is capable of very great benefit to marine signaling, as instanced by the installation at the South Foreland lighthouse, off the British coast. Here signals sent to the French coast affect the instruments on the Goodwin lightship, but this is not objectionable, because each station has a specific "call," just as telegraph offices along land lines do, and unless one is "called" first no attention is paid to the signals. It is doubtless in this realm of coast signaling that wireless telegraphy will prove most valuable. There is no particular reason why Signor Marconi's apparatus should not supply the requirements of such service.

The apparatus for general signaling (as distinguished from the reflected or restricted waves) is simple to crudity. The transmitting apparatus comprises an induction coil, a battery, a signaling key, two discharge balls and a vertical conductor. Fig. 3 shows the arrangement semi-diagrammatically. The induction coil, *I*, is an ordinary 10-inch Ruhmkorff coil, with a vibrator, *v*. The battery *B* is made up of ordinary dry cells, a sufficient number being employed to give about 14 volts. One of the discharge knobs *dd* is connected to earth (or water) and the other to the vertical conductor *W*, which preferably terminates in a metallic plate or sphere, but not necessarily.

The receiving apparatus is shown by Fig. 4, where *C* is a "coherer," connected in between the vertical conductor *W* and the earth, as were the discharge knobs in Fig. 3. This coherer serves as a circuit-closer for the local circuit through the relay *R*, battery *B2*, and coils *QQ*, whose function will presently appear. The relay *R* controls a sub-circuit comprising a register or sounder *S*, its battery *b* and a vibrator *V*, the latter being connected in multiple with the sounder *S*. The sounder and vibrator are "shunted" by non-inductive resistances *ss*.

The coherer is a glass tube, about 1-4 in. dia. and 1 1-2 in. long, with two metal stoppers, between which is a quantity of silver and nickel filings. These filings ordinarily offer a very high electrical resistance, so that normally the battery current cannot get across in appreciable volume, and the telegraph instruments lie idle. When the key *K* at the sending end is closed the induction coil operates to charge

the vertical wire *W* and its terminal with rapidly alternating charges, each discharging across the gap from *d* to *d*. These charges or oscillations propagate waves which set up a corresponding action in the vertical wire *W* at the receiving instrument, as previously explained. The passage of the discharges through the coherer *C* causes its contents to cohere, greatly reducing the electrical resistance between its terminals, so that current from the battery *B2* can flow and energize the relay *R*, which in turn actuates the sounder *S* and the tapper *V*. This tapper or vibrator simply serves to jar the particles within the coherer and cause them to separate when the oscillations up and down the vertical wire *W* cease. As a matter of fact it separates the coherer particles while current is passing, but they cohere again between the blows, and although the circuit of the relay is broken and closed by this action a great many times per second, the sounder *S* is not affected because of the inertia of its lever and the time constant of its magnets, which unite to prevent the

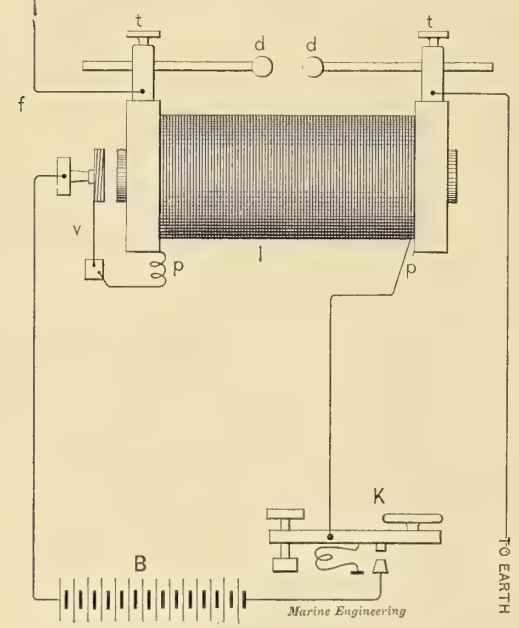


FIG. 3.

lever from following the rapid flutterings of the relay lever. A more positive relief from possible disturbance due to the effect of the tapper upon the relay circuit would be afforded by the use of a polarized sounder or register, affected only by current reversals and not by making and breaking its circuit.

The coils *QQ* are highly inductive, but of low resistance, so that they do not impede the relay current greatly, but serve to "choke" back the oscillating currents discharged by the wire *W* and force them to travel through the coherer instead of allowing them to be wasted in the relay circuit, where they would be inoperative because of their small volume and alternating polarity. The shunts *sss* are used to prevent sparking at the various contacts by reason of the self-induction of the magnets, and also to prevent the exertion of disturbing inductive effects upon the coherer, which, it will be remembered, is extraordinarily sensitive.

When the signals are to be made selective, the coherer is mounted in front of a reflector, as shown in Fig. 5, which restricts its responsiveness to those waves that approach from in front. The vertical wire is taken off, as its presence would, of course, render the reflector at the coherer useless. The coherer is further supplied with "syntonizing" strips of copper *cc*, which must be of such length that their natural rate of vibration is in accord with the frequency of the oscillations to be received. This necessity for fine adjustment constitutes a serious drawback to the use of the selective system. With an ordinary induction coil, several things affect the "frequency." A slight variation in battery strength, change of temperature in the vibrator tongue or a touch of the contact screw may throw it out of syntony with the receiver. When a reflector is used behind the coherer, a similar one is used behind

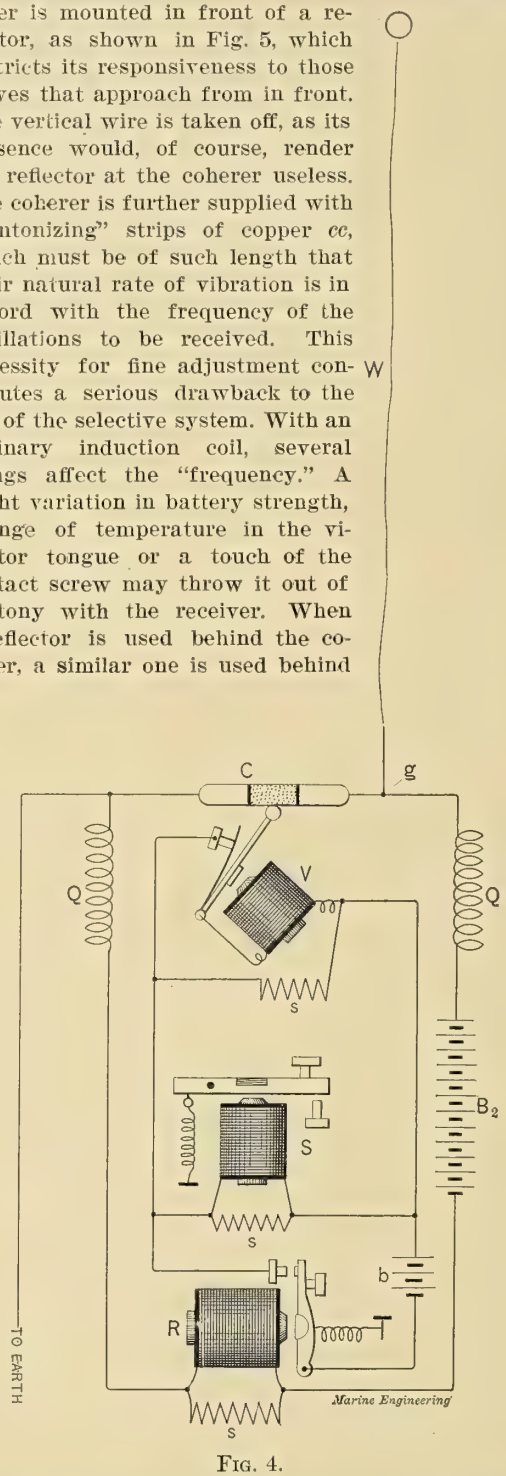


FIG. 4.

the discharge knobs of the induction coil at the sending end, as shown by Fig. 6, and two auxiliary spheres are used to give three discharge gaps in-

stead of one. The vertical wire and earth connection are omitted here also for the reason given before.

Of course each station must have both signaling and receiving apparatus, but only one vertical wire is necessary. The sending and receiving instruments

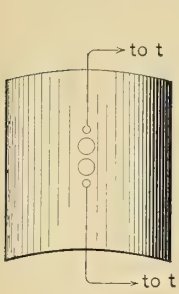


Fig. 6.

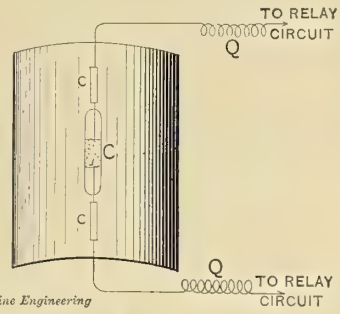


Fig. 5.

are not connected to the vertical wire simultaneously, however. Referring to Figs. 3 and 4, the letters *f* and *g* indicate points at which the connections are changed. A switch is provided which, when thrown one way, connects the vertical wire to the transmitting apparatus at *f*, Fig. 3, and when thrown the other way breaks this connection and transfers the vertical wire to the coherer circuit at *g*, Fig. 4. The coherer is enclosed in an iron box, so that its proximity to the induction coil will not result in serious disarrangement when the operator is sending signals. One immense advantage of the vertical wire system is the ability to locate the instruments in any convenient spot. With the reflector system the instruments must not be shielded by objects which act as reflectors to the waves.

The applicability of the Marconi system to marine signaling is obvious. Lighthouses and vessel masts lend themselves peculiarly to the installation of the apparatus by affording an ideal location for the vertical wires, and once these are established the arrangement of the instruments is a simple matter. The practical advantages of the system will be evident to those interested. Ships can signal to each other and to shore stations over distances of 5 to 15 miles, according to the height of their masts and communication between lightships and shore stations can be maintained regardless of climatic conditions. The system is not affected by weather, temperature, light or darkness, which of course immensely enhances its value as a means of communication in exigencies. Moreover, no peculiar skill is necessary to the manipulation of the vertical wire system, any intelligent person being capable of learning to handle the apparatus in a short time. An inherent disadvantage is the inability to transmit more than one set of waves simultaneously within a given range, so that during fleet evolutions only one vessel can signal at a time. For the mercantile marine the advantages of such a means of communication, as for example, vessels passing at sea, or approaching land in a fog, are so great that should further experiment place the system on a practical workaday basis, its adoption will doubtless be widespread and immediate.

RECENT FULL POWER TRIAL OF THE U. S. BATTLESHIP MASSACHUSETTS.

The battleship *Massachusetts*, with the other ships comprising Admiral Sampson's squadron, underwent a four-hour trial run recently, on the way from St. Pierre, Martinique, to San Juan, Porto Rico. The first two hours were under natural draught and the last two with forced draught. As the *Texas* and *Indiana* participated in the trial, an unofficial race took place and it is reasonable to suppose that every ship was doing its best. Under these conditions therefore it is interesting to compare certain data taken from the official log of the builders' trial of the *Massachusetts* with similar data taken during this run.

Three years have elapsed since Cramps drove her for four hours at a speed of 16.75 knots and developed 10,127.83 horse power. During that period the *Massachusetts* has performed the usual routine work of ships on the home station besides taking part in the Cuban operations. Since then her stacks have been lengthened 10 ft. and her draught greatly improved thereby. Bilge keels have been fitted also, about two-thirds of her length. With these two exceptions she is practically the same ship as the Cramps turned over to the Navy Department in June, 1896.

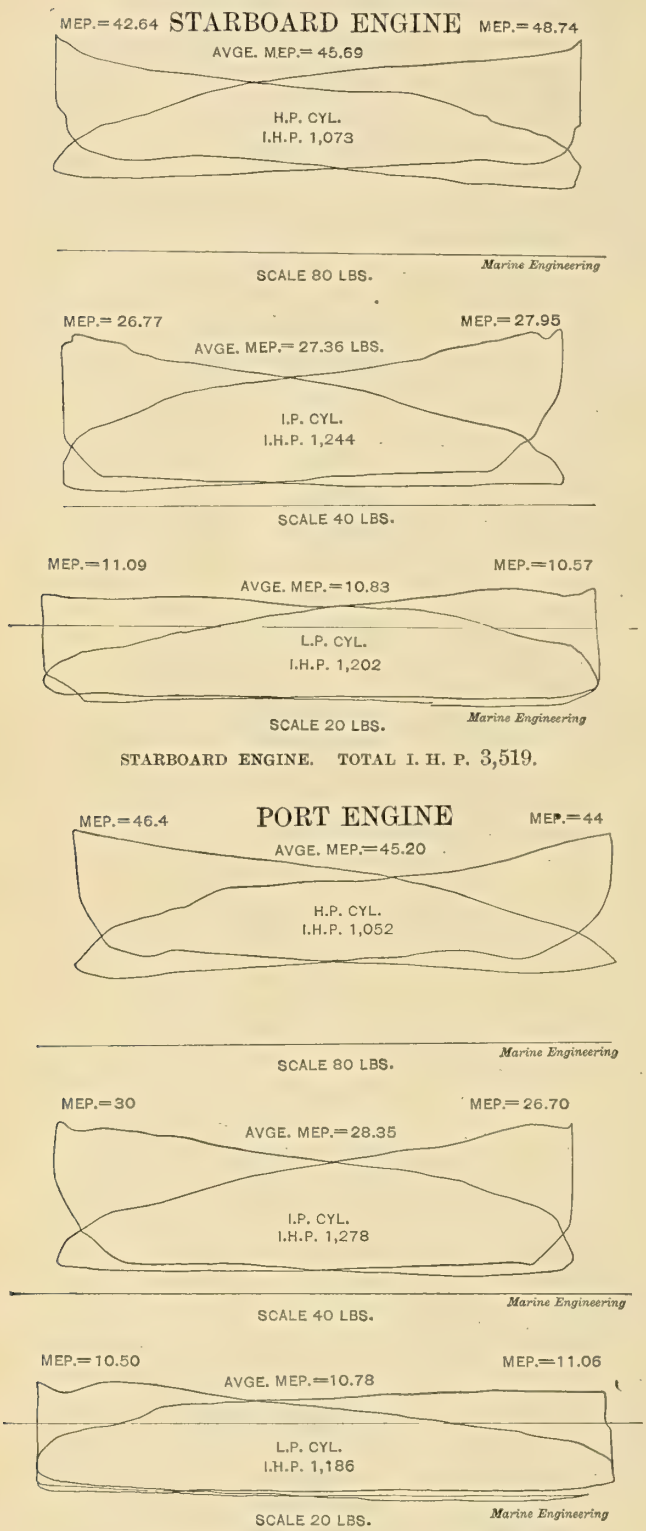
The accompanying data taken during the four-hour run, while not official, were taken by a member of the engine room staff and can be relied on as accurate. All boilers were in use, including the two auxiliary or donkey boilers. The latter were used to supply steam for all the auxiliary engines, such as dynamo, blowers and feed pumps. The main boilers were under natural draught from 7.10 A. M. to 9.10 A. M. and under .75 in. of air pressure from 9.10 A. M. to 11.10 A. M., when the trial ended. The maximum I. H. P. developed during the run was 7,700. In comparing the run with Cramps' trial, it would be well to take into consideration the different conditions prevailing. The official trial took place in the month of April off the Massachusetts coast, while the last run was made in tropical waters. The temperature of the fire rooms was high, and showed a difference of 59 deg. over that registered during the official trial, and there was also a temperature difference in the injection water of 37 deg., as will be noticed on inspection of the accompanying data. The run in every way was a complete success. The engines worked smoothly, and the boilers stood the strain of two hours' forced draught without showing any signs of weakness. A set of cards for each engine is printed on the next page.

Each ship of the five taking part had thirty minutes start of the next one following. The battleship *Indiana* got away first, followed by the battleships *Massachusetts*, *Texas*, and the anchored cruisers *Brooklyn* and *New York*. The *Massachusetts* overhauled the *Indiana*, left the *Texas* out of sight and was two miles ahead of the *New York* when her four hours were finished. The *New York* overhauled and passed the *Brooklyn*, while the surprise of the day was the manner in which the *Indiana* left the *Texas* behind.

The *Massachusetts* is classed as a seagoing coastline battleship and is equipped with two 13 in. and

four 8 in. barbette turrets. She is 348 ft. long on the load water line, 69 ft. 3 in. extreme beam, and has a draught of 24 ft. on a displacement of 10,288 tons.

U. S. S. Massachusetts Under Forced Draft.



Her normal coal supply is 400 tons and her total bunker capacity is 1,597 tons.

U. S. S. *MASSACHUSETTS'* COMPARATIVE LOG OF OFFICIAL TRIAL AND FOUR HOUR TRIAL RUN (3 YEAR INTERVAL BETWEEN TRIALS).

Time of trial.	Engines.	Engine revolutions per minute.	Steam pressure, in pounds per square inch. In boilers, above the atmosphere.	Steam pressure, in pounds per square inch. At engines, above the atmosphere.	Steam pressure, in pounds per square inch. In receiver above a perfect vacuum. 1st.	Steam pressure, in pounds per square inch. In receiver above a perfect vacuum. 2d.	Steam cut-off, in decimals of the stroke, from the beginning. H. P. Cyl.	Steam cut-off, in decimals of the stroke, from the beginning. I. P. Cyl.	Steam cut-off, in decimals of the stroke, from the beginning. L. P. Cyl.	Opening of throttle valve, in tenths.	Vacuum in condenser, in inches of mercury.	Pounds of coal consumed per hour.	Temperature, in degrees Fahrenheit. Engine room.	Temperature, in degrees Fahrenheit. Fire room.	Temperature, in degrees Fahrenheit. Injection water.	Temperature, in degrees Fahrenheit. Discharge water.	Temperature, in degrees Fahrenheit. Feed water.	Revolutions or double strokes per minute. Air pump.	Revolutions or double strokes per minute. Circulating pump.	Speed knots.
Official trial, 1896.....	Stbd.	132.30	163	156.6	80.1	28.05	.673	.678	.706	Wide	25.15	15,800	75.1	96.43	43.5	118.2	114.4	15	159	16.75
	Port.	133.06			74.7	27.9	.673	.694	.712	Wide	25.20		71.7	94.43	43.5	122.9	113.1	18	195	
Two hour natural draft, 1899.....	Stbd.	110.12	151.5	148.5	50	22.5	.690	.678	.704	1.05	24		102	140	80	119.7	112.25	18	140	14.7
	Port.	108.12			51	20.2	.690	.678	.704	1.15	24.5		102	140	80	121.5	125	18	145	
Two hour forced draft, 1899.....	Stbd.	116.46	156.5	152.5	62	24	.690	.678	.704	2.25	23.96	17,650	102.5	155.7	80	132	123	20	160	15.3
	Port.	117.9	156.5	152.5	62.5	23	.717	.694	.706	2.30	26		106.5	155.7	80	123.7	123	27.5	159	

Cramp's official I. H. P.: S., 5,049.95; P., 5,077.88. Total I. H. P., 10,127.83. Maximum I. H. P. during 2 hours' forced draft, 7,700. Average speed for 4 hours, 15 knots.

CONSIDERATION OF THE INDICATOR AND ITS USES ON BOARD SHIP—IV.*

BY R. W. JACK.

To find any other point on the curve between the points already obtained, say when the crank arm makes an angle of 45 degrees with the center line of engines on either side of its mid position, it becomes necessary to compare the acceleration produced during the 45th degree, and this we find by comparing the mean velocities during two consecutive degrees, viz., the 44th and 45th. The mean velocity during the 44th degree in the first quadrant is equal to the distance traveled by the piston during such degree. Let d_1, d_2 and d_3 be the distances moved by the piston from rest at the end of the 43d, 44th and 45th degrees, and y_1, y_2 and y_3 the angles which the connecting rod makes at these points with the line of centers. The mean velocity of the 44th degree is

$$d_2 - d_1 = [\text{(vers } 45°) + (4 \text{ vers } y_2)] - [\text{vers } 440 + (4 \text{ vers } y_1)]$$

During the 45th degree we have

$$d_3 - d_2 = [\text{(vers } 46° + (4 \text{ vers } y_3)] - [\text{vers } 45° + (4 \text{ vers } y_2)]$$

To find the angle y and its versed sine we make use of the table of natural sines, etc. In the right angled triangles (Fig. 12) $B\ C\ D$ and $A\ C\ D$ where $C\ D$ is the common perpendicular

$$\sin y : \sin x :: \text{crank } A\ D : \text{con. rod } B\ D, \therefore \sin y = \frac{\sin x \times A\ D}{B\ D} \quad \sin y = \frac{\sin 45 \times 1}{4} = \frac{.7071068 \times 1}{4} = .1767767,$$

the angle corresponding to which is 10° 11′ (approximate) and the vers is = .0157490. The versed sides of angles 44°, 45° and 46° are respectively .2806602, .2928932 and .3053416, and the angles y_1, y_2 and y_3 of the connecting rod corresponding to the angles 44°, 45° and 46° of the crank are approximately 10°, 10° 11′, and 10° 22′, the versed sines of which are— .0151951, .0157490 and .0163032. The mean velocity of the piston, or the distances it has traveled during the 44th degree of the crank, is therefore

$$d_2 - d_1 = [.2928932 + (4 \times .0157490)] - [.2806602 + (4 \times .0151951)]$$
$$\text{“} \quad = .3558892 - .3414406 = .0144486 \text{ ft.}$$

The mean velocity during the 45th degree is

$$d_3 - d_2 = [.3053416 + (4 \times .0163032)] - [.2928932 + (4 \times .0157490)]$$
$$\text{“} \quad = .3705544 - .3558892 = .0146652 \text{ ft.}$$

The difference of the mean velocities during the 14th and 45th degrees is therefore

$$.0146652 - .0144486 = .0002166 \text{ ft}$$

This, then, represents the acceleration imparted, or the increase in the mean velocities during the 45th degree in the first quadrant of the crank pin circle.

We have found the forces in pounds per square inch of piston area required to communicate to the piston its initial velocity at both extremities, that is the accelerating force on the one side and the retarding force on the other. In the example we are now considering we have found them to be respectively 38.1 lb. and 22.8 lb. per square inch. We have also stated that the distances traveled by the piston during the first and last degrees of the down stroke of the crank are .0001904 ft. and .0001442 ft. Taking the former for comparison, and assuming the piston to fall this distance from rest, the mean velocity is again represented by this distance; but in the case of a body falling from rest the terminal velocity is twice the mean velocity, i. e., if v be the terminal velocity, V the initial velocity, and x the mean, then

$$x = \frac{V + v}{2} \text{ and as V. } = o,\ x = \frac{v}{2} \text{ or } v = 2x.$$

The terminal velocity is therefore, at the end of the first degree $.0001904 \times 2 = .0003808$ ft. per second, and the acceleration during this interval is equal to the difference of velocities, thus, $.000380 - o = .0003808$ ft., because the piston has moved from rest. An acquired acceleration of .0003808 ft. per second is represented by a force of 38.1 lb. per square inch of the piston area, and as forces are proportional to the acceleration produced in a given time the force required during the 45th degree is

$$.0003808 : .0002166 :: 38.1 : x; \therefore x = 21.6 \text{ lb. per sq. in.}$$

To find the force exerted by the crank pin in arresting the velocity of the piston, etc., at an angle of 45° of the crank with the line of centers in the second quadrant, we proceed in the same way. If as before d_1, d_2 and d_3 represent the total distances of the piston from the bottom end of its stroke at angle of 44°, 45° and 46° of the crank with center line of engines, then the mean velocity or distance traveled during the 44 degrees is

$$d_2 - d_1 = [\text{vers } 45° - (4 \text{ vers } y_2)] - [\text{vers } 44° - (4 \text{ vers } y_1)]$$
$$\text{“} \quad = [2928932 - (4 \times .0157490)] - [.2806602 - (4 \times .0151951)]$$
$$\text{“} \quad = .2298972 - .2198798 = .0100174.$$

During the 45th degree the mean velocity is

$$d_3 - d_2 = [\text{vers } 46° - (4 \text{ vers } y_3)] - [\text{vers } 45° - (4 \text{ vers } y_2)]$$
$$\text{“} \quad = [.3053416 - (4 \times .0163032)] - [.2928932 - (4 \times .0157490)]$$
$$\text{“} \quad = .2401288 - .2298972 = .0102316.$$

The retardation at this point on the down stroke is again proportional to the difference of velocities, i. e., .0102316 — .0100174 — .0002142, and stating it as before in comparison with the initial force and acceleration, we have

$$.0003808 : .0002142 : : 38.1 : x.$$
$$\therefore x = 38.1 \times \frac{.0002142}{.0003808} = 21.4 \text{ lb. per sq. in.}$$

We thus have mathematically located five points on the curve, viz., 38.1 lb. at the beginning, 21.6 lb. at 45° in first quadrant, zero on the back pressure line 1.476″ from center, 21.4 lb. at 45° in the second quadrant, and 22.87 lb. at the end of the down stroke. Those points should be marked off from the base or line of counter pressure to the same scale as that of the real diagram and at a distance from either extremity of the indicator card equal to that found by the formula,

$d = \text{vers } x \div (4 \text{ vers } y)$ or $d_1 = \text{vers } x - (4 \text{ vers } y)$ where d is the total distance from the top end, and d_1 is the distance from the bottom.

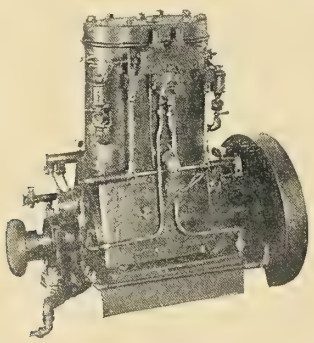
In our present example the only angles taken were 45 degrees in each quadrant, d was found to be .3558892 feet, and d_1 .2298972 ft. It only remains to draw the curve.

*From a paper read before the Institution of Engineers and Shipbuilders at Hong Kong.

IMPROVED APPARATUS.

Sarvent Marine Gasoline Engine.

The accompanying cut shows a Sarvent Marine four cycle gasoline engine which the makers claim to be superior to and more reliable than any built on the two cycle system. They are built with one, two, three or four cylinders. The design is neat, compact and simple. The cylinders are entirely enclosed by one water jacket, which connects with the water jacket in the head. The base is entirely enclosed and contains oil and water in which the cranks slush, thus making all interior mechanism and crank bearings self-lubricating. The piston is so constructed as to always carry oil that is slushed into it by the crank from the base, and thus it lubricates the cylinder at every point of the stroke. The circulating water is discharged from the head through a special port and out through the exhaust pipe, keeping the pipe always cool. The exhaust is carried directly under water,

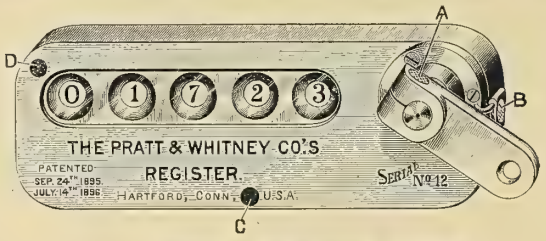


SARVENT MARINE ENGINE.

without the use of a muffler of any kind, thus preventing objectionable noise and odors. The compactness of this engine peculiarly adapts it for auxiliary work in sailing vessels. The engine works under low compression, thus reducing vibration and permitting the use of a lighter fly-wheel and the running of engine at a lower speed. The speed of the engine is controlled by throttling the air valve, which, for convenience sake, may be located in the bow of the boat near the steering wheel. The gasoline tank is placed in the bow of the boat, underneath the forward deck. A pump is provided to keep a constant supply of oil in a small siphon cup located directly under the induction valve and provided with an overflow pipe, which prevents flooding. The overflow returns into the main feed pipe back of the check valve. Air and gasoline meet in the siphon chamber; the mixture is instantly vaporized and the vapor then passes into the cylinder in an even charge. The igniter is what the makers term a snap-break contact, with platinum contact points. The points are so arranged that the charge passes over them on its way to the cylinder, keeping them cool and preventing oxidation. It is provided with an early and late trip. In starting the trip is thrown out, causing the explosion to take place after the piston passes over the center on the downward stroke, and thus avoiding any backward kick of the fly-wheel. The mode of ignition is claimed to be one of the principal advantages of this engine. It is manufactured by the Sarvent-Crider Marine Engine Co., 105 West Monroe street, Chicago, Ill.

Revolution Counter.

A neat and very compact form of engine revolution counter is shown in the accompanying engraving. This counter has five dials; the first dial has a duplex driving mechanism which is one of the important

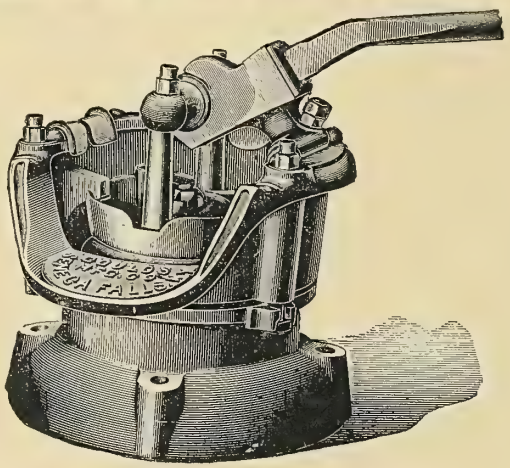


PRATT & WHITNEY REVOLUTION COUNTER.

features, comprising a pawl and ratchet dial actuator, also an escapement driving device working in unison with the ratchet device. The result is absolute certainty of action. The escapement is of such a character that it not only serves to limit the movements of the other parts—so there can be no overthrow—but, should the pawl fail to act, it performs for the time the entire work of operating the dials. The counter is of special interest as an instrument of precision. It is manufactured on the "interchangeable system," by a plant constructed especially for it, and made by the most approved methods of watch-tool manufacture. The working parts are contained within a plain but neat and substantial case—positively excluding all dust and protecting the works against all ordinary accidents. The Counter is manufactured and sold by The Pratt and Whitney Co., Hartford, Conn., U. S. A.

Diaphragm Suction Pump.

An improved form of diaphragm pump is shown in the engraving printed herewith. The lever is reversible and can be used at the back of the pump or



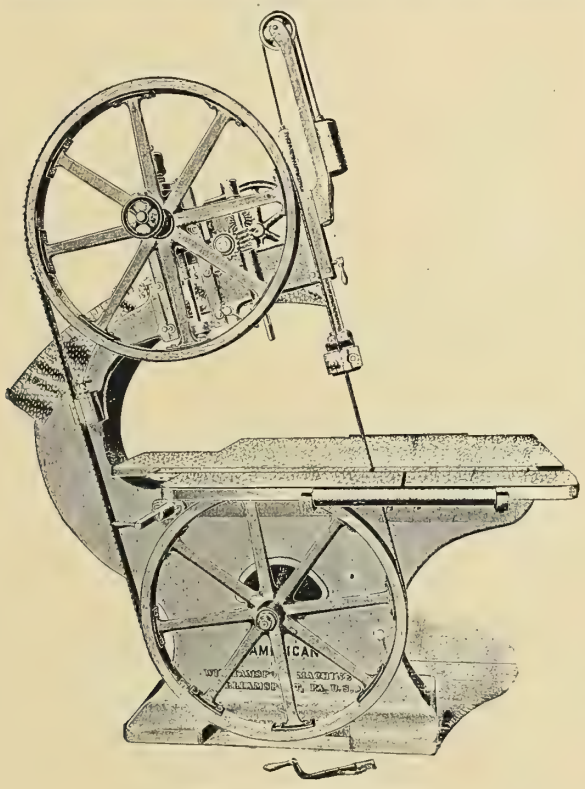
GOULD DIAPHRAGM PUMP.

on either side. The lower valve is made of metal, rubber faced, and is easy of access and readily removable. The waterways are large and easy. First-class materials alone are used in the construction; the

diaphragm, which takes the place of a plunger, being of selected rubber. Pumps of this pattern are particularly adapted for pumping water containing mud, sand, gravel, sewage, coal, chips or any semi-fluid matter. They are fitted with bottom suction for use in places where they can remain stationary, as on vessels, barges, dredges, wharves. Pumps of similar pattern are built with side connection for hose or pipe. The capacity of the pump shown is about 3,000 gallons an hour, the pump having a 12 1-2 in. diaphragm and 3-in. suction pipe. These pumps are manufactured by The Goulds Manufacturing Co., Seneca Falls, N. Y.

Adjustable Bevel Band Saw.

The accompanying engraving illustrates a new adjustable bevel band saw just introduced by the American Wood Working Machine Co., and built at their Williamsport Machine Co. factory at Williamsport, Penn. This machine is intended for all classes of band sawing where heavy stock is to be sawed beveling, and is specially adapted to the uses of shipyards. The main frame is very heavy and rigid, having cored sections, and is cast in one solid piece. Wheels are 40-in. dia. and 2 1-2-in. face, with wood rims built up of cants turned off true, covered with rubber and perfectly balanced. Hub and spokes are cast in one piece, to which the wood rims are securely bolted, making the best wheel that can be made. The spokes cannot get loose, as is often the case where the spokes are made separate and fitted into the hub.

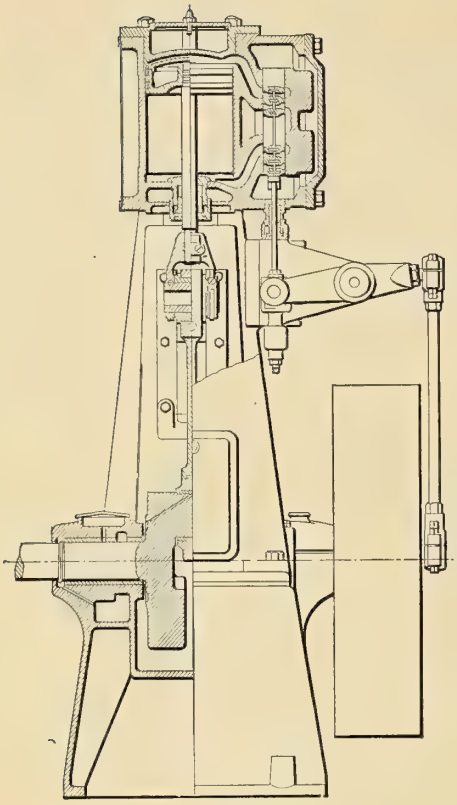


BAND SAW FOR SHIPWORK.

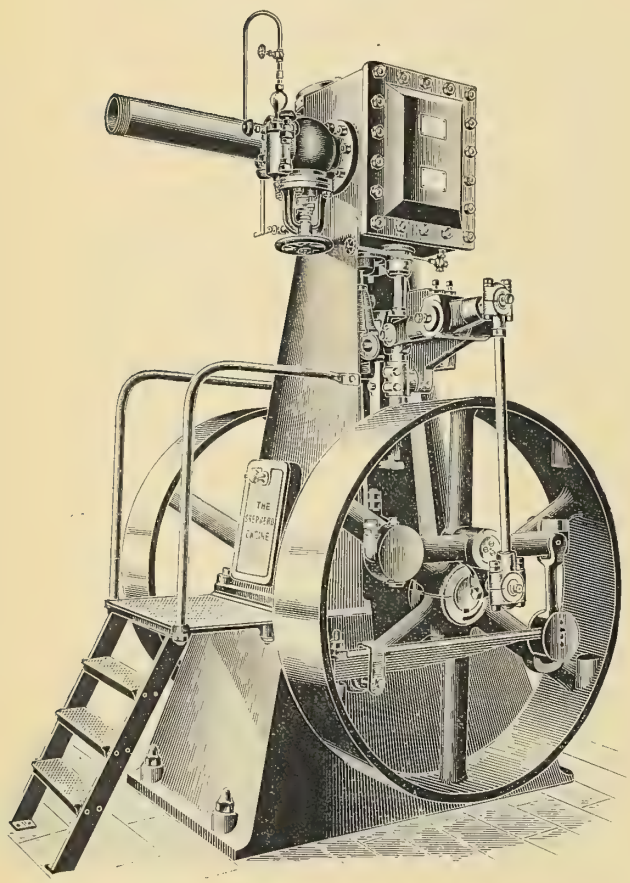
The top wheel can be adjusted to saw from square to an angle of 45 deg., either by means of the crank shown at the base of the machine, or by a hand wheel at the opposite side; and both top and bottom wheels are adjustable for tracking the saw on the wheels. The upper guide is fitted with a steel roller for the back of the saw to bear against, and has hard maple guides to run against the face of the saw. The table is iron, and is provided with an iron roller at front and rear for relieving friction on the table when sawing heavy stock. Adjustable iron plates are fitted into the table to close the opening when saw is adjusted. The shafts are very heavy and run in long bearings lined with good babbitt metal, and the lower shaft is provided with a bearing outside of the tight and loose pulleys. The machine will receive lumber up to 17 in. thick and will carry saws up to 2 1-2 in. wide. Further information can be had upon application to any of the branch offices of the company, or to the New York headquarters, 80 Liberty street.

Shepherd Automatic Engine.

The Shepherd Vertical Automatic Engine was designed with a special view to direct connection to electric generators and other fast running machinery, such as fans, pumps, blowers, etc. It combines, with simplicity of construction and symmetry of form, the greatest degree of rigidity and strength. While representing concentrated power in the minimum space, convenience and accessibility to the working parts have not been sacrificed in obtaining compactness, nor has simplicity been gained at a loss of efficiency. The Shepherd engine is compact in the sense of being convenient and easy of access without any waste of space, and at the same time rigid and self-contained. It is simple in that it consists of but few parts, and all wearing surfaces are provided with the most accurate adjustment for taking up wear. The simplicity, the high speed at which it is capable of being run, the general good design and liberal wearing surfaces, and the very small space a given power occupies, make this engine particularly desirable for driving direct-connected generators for lighting on steamships, yachts and ferry boats, as well as for power or lighting purposes at wharves, docks or other isolated stations. The engine is clean and neat in operation; not a drop of oil need be thrown about on the engine-room floor or walls. The bed and frames are of cast-iron, well ribbed and braced, and within them are contained the cross-head guides, the main bearings and the valve gear support, thus making it impossible for the working parts to get out of line, except for wear, and adjustment for this is provided. The back frame contains the guides and the rocker-arm bracket, and it supports the cylinder when the front frame is removed to take out the crank-shaft, if need be. The cylinder and steam chest are cast together. The cylinder barrel and both top and bottom heads are jacketed with an air space or some non-conducting material. The valve is double ported for both steam and exhaust; and it is self adjusted for steam tightness, thus automatically following up all wear. It is also collapsable and acts as a relief valve in case of water in the cylinder. The governor is of the well-known Shepherd type, which gives remarkable results in the way of close regulation. It combines simplicity with freedom from dirt, no oil being used about it in any way; and there is no noise or pounding even after long use. The crank-



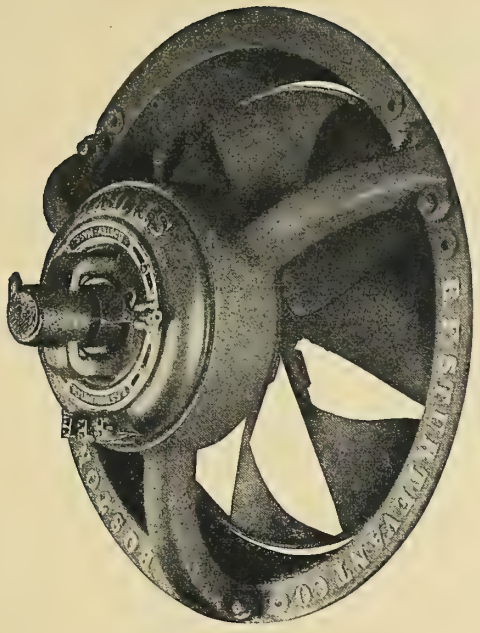
SHEPARD AUTOMATIC ENGINE.



shaft is of solid steel, correctly counterbalanced. The crank pin and main bearings are of very liberal proportions, and they are automatically oiled by means of ring or chain oilers, which keep a continuous stream of oil running over them at all times. The piston rod, connecting rod, valve and eccentric rods, pins, bolts, etc., are all of steel, accurately machined. The cross-head is of phosphor bronze or cast steel. The engine is built by the American Fire Engine Company, Seneca Falls, N. Y., and is made in both simple and compound types; the latter, both cross and tandem styles, being adapted either for belted or for direct connection. Our illustration shows the type covering a range of sizes from 75 to 200 horse power.

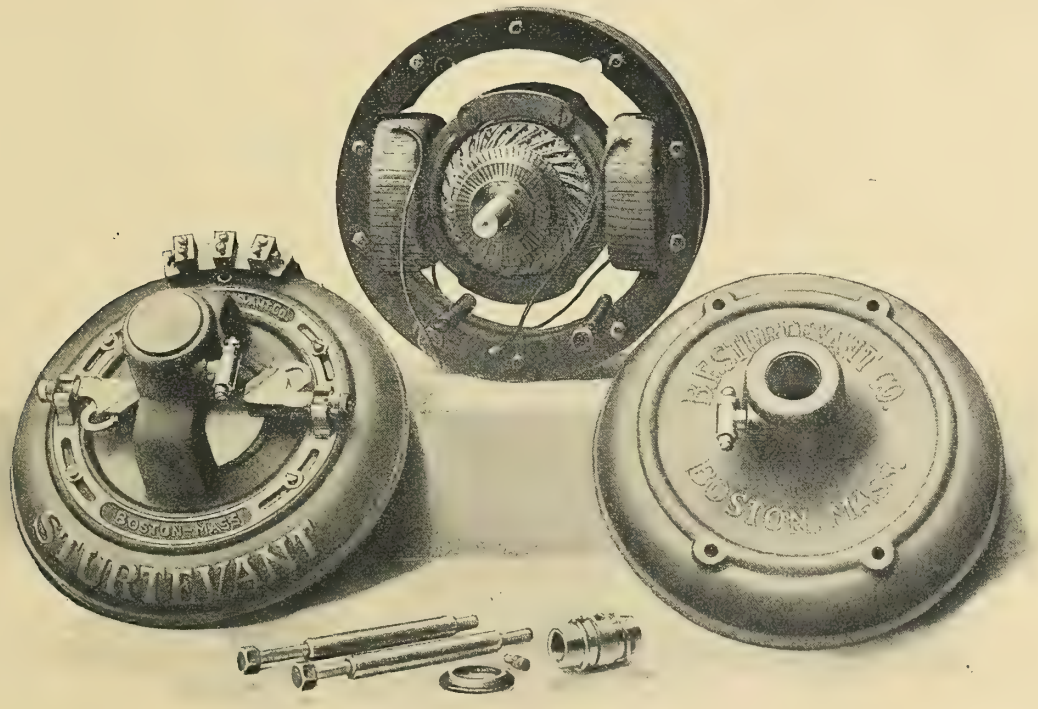
Electric Ventilating Fan.

Although the propeller or wing type of ventilating fan has been equipped with various types of electric motors, the design of these motors has hardly received the attention demanded by the importance of the work performed by such machines. The B. F. Sturtevant Co., of Boston, Mass., has of late been giving the entire subject very thorough investigation, and is now presenting an entirely new type of fan wheel and of direct connected motor, as shown by the accompanying engravings. The wheel has been designed to secure the highest efficiency, and consists, in the size shown in the illustration, of eight blades, secured to a light but stiff hub, and held in their relative positions by a hoop at the periphery. The delivery edge of the fan wheel is helical, so that the air is picked up at the inlet edge at low velocity, and gradually accelerated to its maximum velocity with the least amount of slip. The motor presents specially interesting features, and from the accompanying description it is clear that the design is the result of most careful study. Manifestly to produce a motor having low temperature rise, it is imperative that the efficiency be made as high as possible. Heretofore the name of enclosed motor coupled itself instinctively with high surface temperature of enclosing case, but in the present motor the temperature rise after 10 hours' run is 27 to 30 degrees Fahr., against 60 to 80 degrees Fahr., a figure frequently met with in practice. This low temperature rise has not been obtained by increasing the size or weight above any of the existing types, but by designing the motor to fulfil the following conditions: (1) The production of a magnetic field of the greatest possible quantity in proportion to the rated horse power. (2) The excitation of this field with the least possible consumption of energy. (3) Suitable material for poles to eliminate eddy currents and heat loss therein. (4) Pole pieces of such design as to prevent distortion of magnetic field by armature flux and the consequent low reduction of the self-induction of the armature coils. (5) Arrangement of magnetic circuit such that the leakage is small. (6) An armature in which the core and resistance losses are reduced to a minimum. The first requirement is fulfilled by using soft and highly permeable sheet iron stamped to the required form and assembled to the correct thickness. The use of laminated iron satisfies the demands of small exciting energy and elim-



ELECTRICALLY DRIVEN FAN.

inates eddy currents and heat losses in pole pieces. The shape of the pole pieces shown in the cut imposes so great reluctance to armature flux that its disturbing effect at full load is negligible, and at the same time lowers the self induction of armature coils by the fact of the pole pieces being saturated. The conditions of small leakage of magnetic flux are met by having the poles, or parts in magnetic circuit, possessing great differences of magnetic potential, of small area and placing the exciting coils as close to the armature as possible. The observed leakage in this machine is less than one-half that of many of the types in use. To reduce the core losses, only the best quality of annealed sheet iron is used, the plate being japanned before assembling on shaft to avoid eddy currents. The resistance and amount of copper on the armature core is, of course, comparatively small, on account of having a magnetic field of great quantity, as before mentioned. By observing the conditions above enumerated in the design of this type of motor, an efficiency of over 80 per cent is obtained at brake, and this in a 1-2 K. W. 500 volt motor running 1,300 R. P. M. The sparking attendant on changes of load has been entirely eliminated, so that a load of 175 per cent of rated capacity of motor may be carried with absolutely no sparking, the position of brushes remaining unchanged. This feature, combined with small temperature rise, allows of temporary overloads being carried with impunity. Referring to the cuts it is observed that the arrangement for supporting the brush holders is a departure from existing methods and gives great rigidity to brush-holders. The leads to the brushes are brought through from the rear, thus doing away with any dangling connecting wires. The brushes are of hard carbon in holders of a modified reaction type that allow of easy adjustment when it becomes necessary to reverse the direction of rotation of the motor. In such a case the field connections are reversed at the terminal block. These motors are built in the two pole type in sizes of from 1-4 to 3 H. P., and in a similar type, but multipolar up to 20 H. P. All of these motors are also built as independent machines, and are particularly convenient for the operation of small machines, tools and the like. The fan wheels with connected motors are constructed in sizes from 18 in. to 120 in.



STURTEVANT PROPELLER TYPE VENTILATING FAN.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY

ALDRICH & DONALDSON,

World Building, New York.

Editorial Department,
H. F. DONALDSON.

Business Department,
H. L. ALDRICH.

Branch Offices,

Philadelphia, Pa., Mach'y Dept , The Bourse, S. W. ANNESS.
Detroit, Mich , 47 Hodges Building, L. L. CLINE.
Chicago, Ill , Monadnock Block, S. W. HUME.

Special Representatives,
J. E. WHITTLESEY. H. N. DINSMORE.

TERMS OF SUBSCRIPTION,

	Per Year.	Per Copy.
United States, Canada, and Mexico	$2.00	20 cents.
Other countries in Postal Union	$2.50	25 cents.

Entered at New York Post Office as second-class matter.

A CAREFULLY prepared comparative statement of the conditions of American shipping and shipbuilding, from Revolutionary times down to the present year, will be found in another part of this issue, together with the author's views of the future. By the aid of graphic illustration, he has stated the case so plainly that at a glance the history of the subject can be read. These tables are of immense interest as showing, unobscurely, not only the past and present position of the country, but also the general trend of what we may term marine affairs. An inspection of the charts will show that, with a single exception, the "peak" condition of American maritime interests was attained at the time of the Civil War, and that since there has been a tremendous "drop," with a recent upward tendency. The exception is the coasting trade, which at the close of 1898 had reached nearly 4,000,000 tons, the greatest amount in any year in our history of navigation. Though it is generally understood that the Civil War was the chief cause of the decline of the American merchant marine, the immediate effect of that war is not so generally realized. This is vividly depicted by the table of "American tonnage sold to foreigners," in which the Civil War period is shown to represent a loss of about 280,000 tons. The energy and capital which were diverted from marine pursuits during that period of strife have, to a considerable extent, remained away. After the war both found an outlet in the development of the West; a development which really, as a display of national energy and enterprise, more than offsets the decadence of shipping interests. Railroads absorbed the mechanical ingenuity of the people, and provided an outlet for speculative capital; and the tremendous number of public works of every description that followed in the train of civilization also gave ample opportunity to engineering science and the mechanic arts. But for this reaching out westward the coal and iron, which now can be laid down at any point with cheapness and despatch, would not be available in the present abundance. Now, however, that this period of exploration is completed and the country is reaching out across the waters, both in trade and sovereignty, the same cry for means of communication goes up that was heard from the Western pioneer. With the men and the material, and the tremendously greater capital available, will not this cry be responded to as adequately on the sea as on land? There are differences in the situation as wide as the differences between the means of communication on land and sea, but there is the same ultimate result—transportation. Chief, of course, among these differences is the question of competition, which on sea is not between one corporation and another of one kind, but among widely different peoples, each striving desperately to hold what they own and get all the benefit of the natural growth in the world's over-sea trade. It is this feature which makes some form of State aid or encouragement a necessity when the weak (as individuals) come into direct competition with the strong. Our author, Geo. R. McDermott, N. A., who comes to the subject equipped with an extensive professional experience on the Clyde and a long study of the conditions in the land of his adoption, advocates a system of bounties. With that clear insight which his former coutrymen are famed for, he looks past the gilded liner and sees in the dingy tramp the real foundation for a merchant marine. It is to this type of vessel, which carries cheaply and well the product of our mills and farms to foreign lands and brings back raw materials, to be in turn reshipped, that we must

look for a proper solution of the problem. Another plan of State encouragement is suggested by a writer in the current issue of *The Atlantic Monthly*, and in proposing a remedy for present conditions he says:

The first step in this direction should be the formation of a body similar to the British Board of Trade, or a Department of Merchant Marine like the Department of Agriculture, in order that the interests of shipowners and seamen and all maritime matters may receive particular and constant attention. The head of this department should be a Cabinet officer. He should be chosen to his position by the advice of the chambers of commerce, shipowners and ship masters' associations of the country. The department should have under its control all seaboard consuls, who should be chosen from past officers of the boards of trade, naval officers, and shipmasters, and should hold their office until incapacitated by age. It should inspect, while building, every vessel put together in American yards, performing this service without expense to the owner. Examinations for the positions of master, mate and engineer should be part of its duty. But this is only in the line of general improvement. Something more specific and radical is needed to place the United States on an equal marine footing with England—some measure that will protect and invigorate the industry without being a protective law. To that end, it is suggested that in connection with the department there should be a liberal system of marine insurance. Every ship built under government inspection and engaged in foreign trade should have her hull insured free; the department with the United States Treasury behind it acting as underwriter. And all cargoes carried by over-sea routes under the American flag should be insured at a lower rate than that offered by foreign insurance companies.

There are wide and honest differences of opinion as to the best means of resuscitating the merchant marine. With the admitted necessity for action, and the diversity of methods proposed, the most sensible plan, it seems to us, would be the appointment of a Federal commission to make a searching inquiry into all phases of the subject, not only from the shipowners' but the shipbuilders' and shippers' points of view, and to reach a decisive and conclusive opinion in the form of a recommendation for Congressional action. Such a commission should not be a party affair, but should be organized on broad lines, and include in its membership a sufficient number of unbiased experts to outweigh any merely political influences.

IN view of the divergence of published opinions and prophecies concerning the Marconi system of space telegraphy, which have tended somewhat to confuse the average reader, the article on this subject that appears on another page should prove of particular interest. From the exposition of the system here given it would seem that its limited application to marine signaling is a practical possibility even now, it being only necessary to equip sea-going craft with the simple apparatus described in order to enable them to communicate with each other over considerable distances. As pointed out in the article, the signals can be made selective only at the expense of radius of action, and when selective apparatus is employed its extreme delicacy of adjustment constitutes an additional drawback. These facts, however, in no wise detract from the practical value of the system as applicable to the merchant marine. There is no special need for secrecy in signals, and if there were, it would be just as effectually obtained by means of private codes as by means of selective apparatus. Such apparatus, as a matter of fact, could not always give perfect immunity from intrusion; the reflector at the transmitter would not prevent the hostile ship from moving into range, and the reflector at the receiver could not monopolize all of the magnetic waves—nor could the intruder be prevented from adjusting his receiver into syntony with the selective transmitter, much as a telegraph operator adjusts his relay for different sending stations on a "heavy" land line in bad weather. So there really appears to be small incentive to the development of selective apparatus, its value being limited to use by naval fleets or intermediate coast stations in order to permit the simultaneous transmission of two or more sets of signals, within a given sphere of influence, without mutual interference. So far as the vertical wire system is concerned, there seems to be no particular reason why it should not be made the subject of practical experiment on sea-going vessels and in coast-line Government stations. The equipment is inexpensive, and the results reported from the installation on the south coast of England are amply encouraging. Any telegraph operator can learn to manipulate the instruments within less time than is required to describe them, and a speed of twenty words a minute is said to be practicable with existing apparatus. Although we are not given to theoretical speculation, more or less irrelevant to work-a-day application, it is of interest to note that the explanation given in our article of the basic principle of Marconi's system has been confirmed by addresses and papers by eminent European authorities, which have been published since the preparation of the article.

CORRESPONDENCE DEPARTMENT.

[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced, if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publications of these will be withheld where requested.

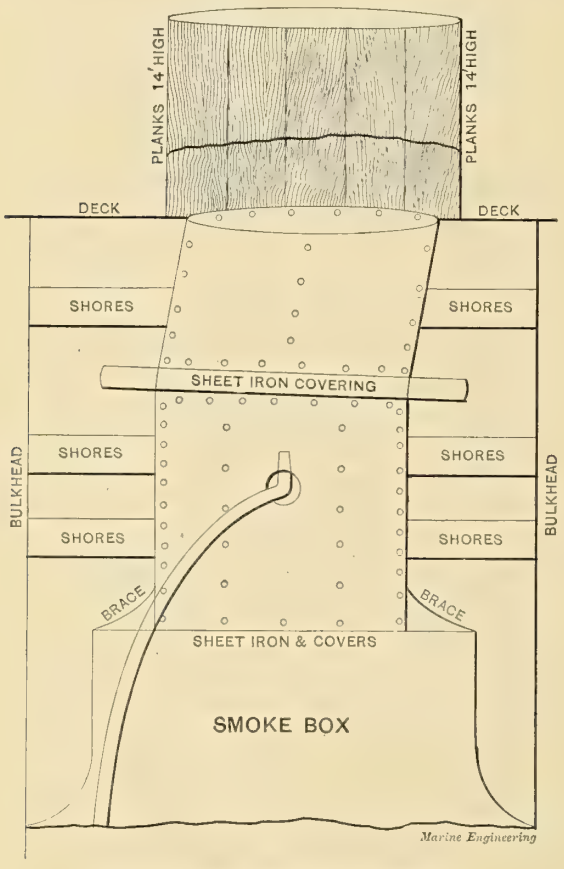
We do not assume responsibility for the opinions expressed by correspondents.]

Engineers Saved the Ship.

Editor of Marine Engineering:

It may interest your subscribers to read a true account of a recent trip of the American steamship *Catania*, 2,600 tons, from Glasgow to New York. On that trip the crew experienced the sensations of persons who realize that they are to be lost at sea. Had it not been for the heroic work performed by the engineers the vessel would surely have foundered and no one lived to relate the story of the struggle to save the ship, a struggle probably as severe as any in the history of steam navigation.

December 18, 1898, the *Catania* left Glasgow in ballast for New York, and all went well until December 21, when the vessel met with a series of hurricanes



JURY FUNNEL AND UPTAKE REPAIRS.

from the northwest which continued and increased in fury from day to day. On December 25 she was boarded by seas which carried away the galley skylight, smashed the sanitary tanks and two life boats. Next day a sea broke over the vessel and carried away her funnel, which broke off at the base on top of the breeching, leaving a 20 ft. section floating around in the fiddlies. The remaining 45 ft. was broken off flush with the deck and carried overboard along with the skylights, life boats, part of the bridge and the port rail. The fires were extinguished, and the vessel lay helpless in the trough of the sea. The engineers worked all night inserting a 2 1-2 in. steam jet in the breeching and shoring up the section in the fiddlies. We tore off the galvanized iron covering from the boilers and patched the holes and seams where the funnel had parted. Then we nursed the fires with oil, generated 20 pounds of steam, got the bilge pumps going, and the engines turning over, about 25 revolutions, and hove the ship to. At daybreak another sea boarded us, putting out the fires again, and starting the starboard boiler from the saddles. The water column pipes (flange ends on boiler) broke and drove every one out of the fire and engine rooms. We were working like fiends getting things in shape, when the Atlantic Transport liner *Mesaba* was sighted in latitude 48 deg. North, longitude 38 deg. West. All the engineers were below and did not know what was transpiring on deck until the next day. Our Captain signaled distress, and asked to be taken in tow by the *Mesaba*. They tried to launch a boat, but it was too rough, and they had to give up the attempt, but they signaled that they would stand by. This they did for 26 hours. Meanwhile the engineers had shored up the loose boiler and had stretched and reflanged the pipe. Then we generated steam and commenced to turn the engines over. At 7.30 p. m. our Captain headed the ship S. by S. E. for the Azores, 790 knots distant, without firing any signal, thus deserting the *Mesaba*, which had stood by us for hours, without a word of explanation. I had the satisfaction later of seeing the Captain regret his act and hear him say, "It remains for the engineers to save the ship."

We had really only got out of one difficulty to meet another still greater. On December 30 the quadrant of the rudder post parted and the vessel fell into the trough of the sea again. The engines raced so hard that Nos. 3, 4 and 5 couplings were loosened (chewing them down three-quarters of an inch. The babbitt metal in the H.P. crank brasses was punched out, and the connecting rod split through the center from the stub end. We were then 790 knots from the nearest port, without a funnel, with the after hold half-full of water, intermixed with mud ballast, with fires extinguished, the quadrant on the rudder overboard, the crew paralyzed with fear, and a Southwest hurricane blowing—that was our New Year's greeting of '99.

After 36 hours' incessant work, during which no one even thought of eating, as it was not to be had, we got steam on again, and finally brought the ship into Ponta Delgada, Azores, with a jury funnel, a patched-up quadrant and other makeshift repairs. We sailed again from the Azores, and arrived at New York harbor, February 7 last. A few days later one of the New York daily papers came out with a long article telling how the Captain saved the ship. I wrote telling them the facts, but my letter never appeared.

THEO. KALISHER,
Second Assist. Eng. S. S. *Catania*.

Discussion of Boiler Manholes.

Editor of Marine Engineering:

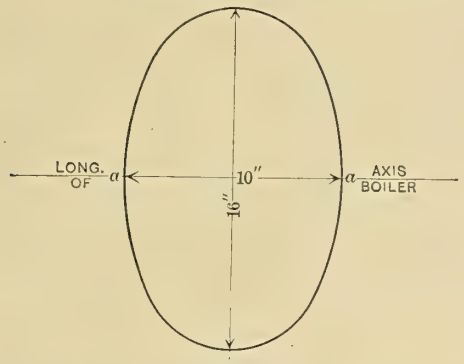
In the April number "Subscriber" asks for a rule to figure the strength of reinforcing rings for manholes. The answer given hardly covers the case. U. S. Inspection Rule says that as much metal must be put around the hole as was taken away. "The Locomotive" (Published by Hartford Steam Boiler Ins. Co.) December, 1896, and April, 1897, has the most complete analysis of the subject to be found anywhere.

The method of treatment, I think originated with Chief Engineer Shock (see his work on Steam Boilers) and is as follows:

When a hole is cut in the shell of a boiler, the strain which the part removed bore must now be carried by the metal at the two edges of the hole in the axis through the middle of the hole and parallel to the longitudinal axis of the boiler.

In the sketch herewith a hole 10 in. by 16 in. is cut in the shell of the boiler. Now it is evident that the

10 in. cut away must be carried by each side, an equal amount. If the shell is 1 in. thick, a piece of metal 1 in. by 5 in. must be placed at points marked *a a* in order to make this part as strong as before the hole was cut. The strap and edges of hole are put into



tension, the same as any other point at the circumference and this equals: radius of boiler × pressure × distance between edges. One-half of this product equals strain at one edge.

CHARLES J. ENGER.

[The answer in the April issue referred to had especial reference to the reinforce rings for manholes in the flat heads of boilers. Practice varies very considerably in the methods of reinforcing such openings, and also of closing them. For manholes in flat heads the chief object of the reinforce ring is to give local strength and stiffness at the edges of the hole, so as to prevent the metal from crushing or buckling under the stress due to the cover or the dogs.

The stress around a manhole and the proper cross section of a reinforce ring are matters which cannot be satisfactorily examined by simple mathematical process. Whatever the stress in the metal at the edge of the hole may be, however, it is certain that it is not one-half the product of "radius of boiler × pressure × distance between edges," given by our correspondent.

Shock in his book on boilers, to which our correspondent refers, concludes that 65 per cent of the section of metal removed is sufficient for the section of the reinforce ring. This

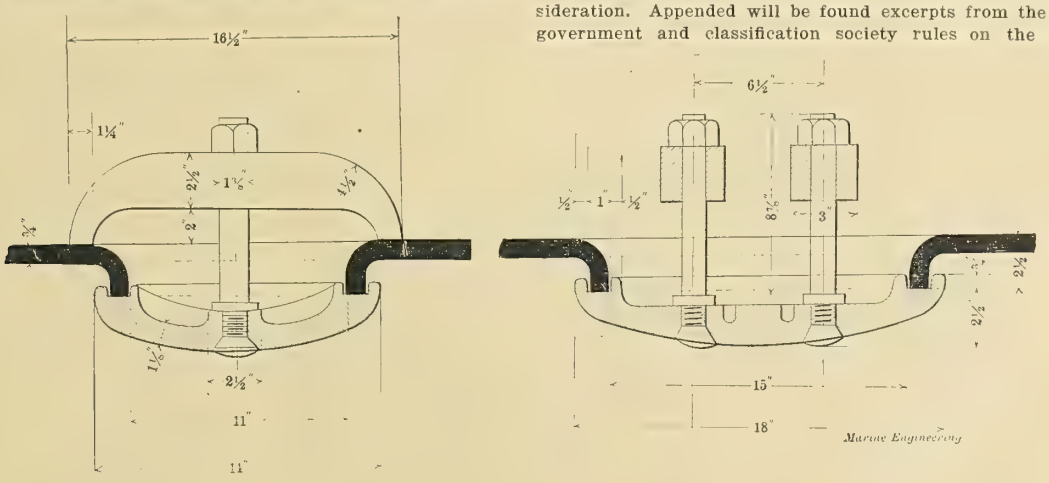


FIG. 1.—MANHOLE IN FLAT HEAD OF CYLINDRICAL BOILER WITH FLANGED OPENINGS.

matter, like so many others in engineering, must ultimately be settled by safe practice.

In manholes in the front of boilers, the reinforce ring, as we originally described, is usually adopted. In modern practice, however, it is often the custom to flange the plate at the hole, and in such case no reinforce ring is used.

A dimensioned drawing of such an arrangement is given here, Fig. 1. Again, where a manhole or handhole comes close to the through braces, say, for example, below the furnaces, in a Scotch boiler, the reinforce plate is cut in a shape approximating a triangle. At each angle or corner the plate is of sufficient width to let the threaded end of the brace come through, and the outside nut is then jammed down on the reinforce ring, which there takes the place of a washer. This we show in the acompanying drawing, Fig. 2.

Now with regard to the manhole on top, in the shell of a boiler: In earlier days, when steam pressures were low, it was frequently the custom to place a metal box over the manhole riveted on from the outside. The top of this box was faced and covered by a plate held in position with stud bolts or through bolts, after the fashion of a cylinder cover. When steam was up, the tendency of the pressure was to lift the whole contraption off the boiler. With the increase

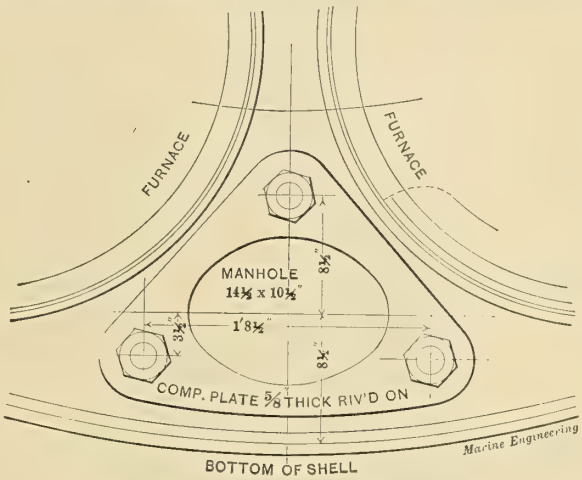


FIG. 2.—MANHOLE BELOW FURNACES.

of pressures some more substantial form of compensation and door was demanded. Doors closing from the inside and held in place with dogs were adopted. In these the tendency of the pressure is to keep the door tight on its seat.

There is no fitting on a boiler which demands greater care in construction than the manhole, though it is not usually looked upon as a problem requiring more than passing consideration. Appended will be found excerpts from the various government and classification society rules on the subject; some give it but brief mention, and other societies do not recognize it at all. Any one who has gotten out of a stokehold in a hurry when a manhole joint blew out will agree as to the importance of the subject.

We give here sketches of actual practice in high-class boiler work. For moderate pressure a cast steel compensating ring, such as shown in Fig. 3 is satisfactory. The flange should be wide enough to permit a double row of riveting, and the

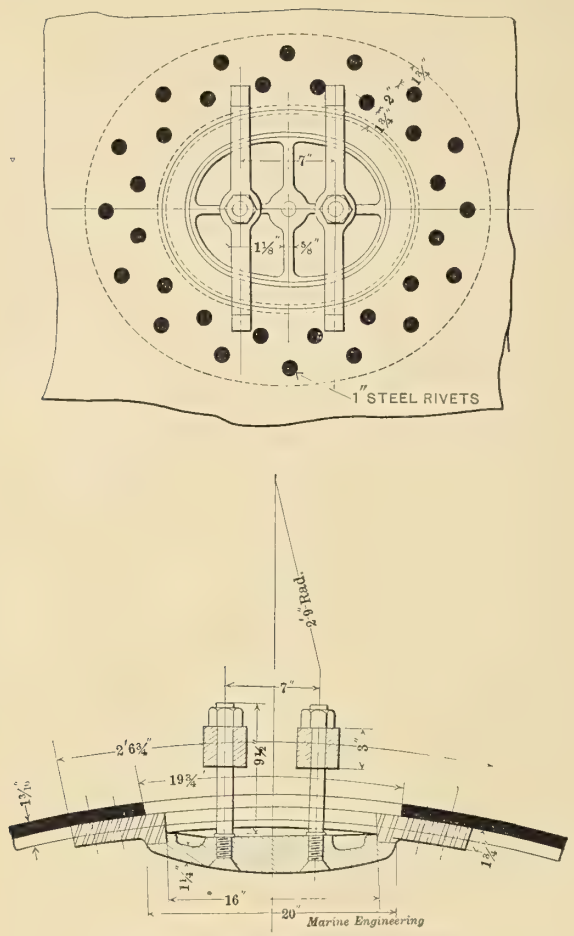


FIG. 3.—12 x 16 MANHOLE IN SHELL.

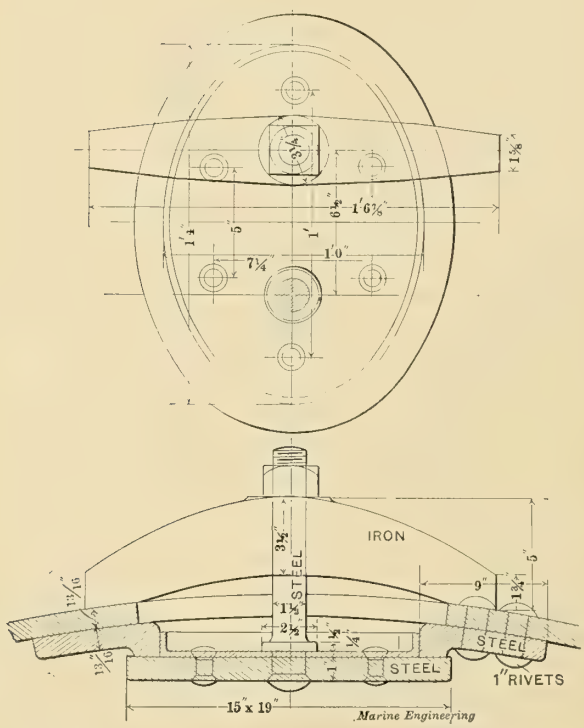


FIG. 4.—12 x 16 MANHOLE IN SHELL.

opening should be less than the opening in the boiler shell. This permits the inner row of rivets to be placed close to the edge of the hole in the shell, so that there will be no spring in the plate when caulked, and a staunch job will result.

The face of the compensating ring should of course be turned true, and the flange of the door faced where the joint is made. Great care should be taken with this joint, the scraper being used if necessary to get true surfaces. The rim running round the cast steel door, Fig. 3, brings the door readily to its proper position and prevents any lateral play. A very safe method of making the joint is illustrated in Fig. 1, already referred to, where the flange in the plate around the hole fits a groove in the door. This is frequently used in the largest work, but it is a more difficult construction than that shown in Fig. 3. In the case of manholes in the shell of this type the curved plate is not flanged, but a heavy angle is riveted on, somewhat after the style of Fig. 4.

The form of door illustrated in Fig. 4 can be recommended for the very highest pressure. It will be noticed that only forged or rolled material is used in its construction. The reinforcing ring is made of the same material as the boiler shell and is the same thickness. It is flanged and then drilled for the rivets and the face is turned true. The door is a slab of high carbon steel of greater thickness than the shell. Riveted to this is a heavy angle, which is a snug fit for the opening in the reinforcing ring. The holding down bolts are steel and the dogs are iron, both of heavy material. The door shown is for a boiler about 12 ft. dia. carrying 125 pounds pressure. For a higher pressure a door of the same design, but proportionately heavier, would be quite suitable. Jointing can be effected by the use of a thin asbestos gasket.

In all cases the short diameter of a manhole in the shell should be placed longitudinally and the long diameter around the boiler.

Following are the rules of various bodies which regulate the construction of manhole fittings:

U. S. Board of Supervising Inspectors.—When holes exceeding 6 in. in diameter are cut in boilers for pipe connections, man and hand hole plates, such holes shall be reinforced, either on the inside or outside of boiler, with reinforcing plates, which shall be securely riveted to the boiler, rivets spaced as for stay bolts, as determined by Section 6, Rule 2, such reinforcing materials to be of wrought iron or steel rings, of sufficient width and thickness of material to equal the amount of material cut from such boilers in flat surfaces; and where such opening is made in the circumferential plates of such boilers, the reinforcing ring shall have a sectional area of at least one-half the area of material there would be in a line drawn across such opening parallel with the longitudinal seams of such portion of the boiler. On boilers carrying 75 pounds or less steam pressure, a cast-iron stop valve, properly flanged, may be used as a reinforce to such opening. When holes are cut in any flat surface of such boilers, and such holes are flanged inwardly to a depth of not less than 1 1-2 in., measuring from the outer surface, the reinforcement rings may be dispensed with.

Bumped heads may have a manhole opening flanged inwardly when such flange has a sufficient depth and thickness to furnish as many cubic inches of material as were removed from the head to form such opening.

Board of Trade, London.—Compensating rings of at least the same effective sectional area as the plate cut out should be fitted round all manholes and openings, and in no case should the rings be less in thickness than the plates to which they are attached. The openings in the shells of cylindrical boilers should have their shorter axes placed longitudinally. It is very desirable that the compensating rings round openings in flat surfaces should be made of L or T iron. Cast-iron doors should not be passed.

Bureau Veritas.—All manholes to be fitted with compensating rings.

Lloyds rule is the same as that of the Bureau Veritas.

Resetting a Slipped Eccentric.

Editor of Marine Engineering:

In your April issue, your answer to a question about setting a slipped eccentric is all right as far as it goes, but it does not get the eccentric exactly right, as the valve may leak, which would make it very un-

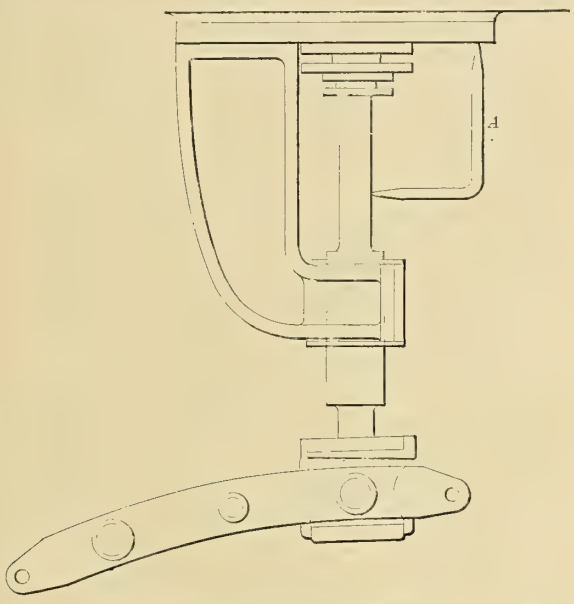
certain. The way to do it and have it right is, to put the engine on the center and place the slipped eccentric somewhere near its proper position, then put the link in full gear with the eccentric that has not slipped, and make a fine mark on the valve stem, say one inch from the stuffing box gland. Then throw the link in full gear with the slipped eccentric and move it (the slipped eccentric) until the mark as before is one inch from the gland, then make it fast.

It must be right with the engine on the center; it does not make any difference which way the engine is going to turn, the valve must have the same lead.

G. V.

[Our correspondent is in error in assuming that an engine must have the same lead whether turning ahead or astern. This would be so had both eccentrics the same setting, but frequently this is not the condition. The correct way to set a Stephenson valve gear of a marine engine is to have a smaller angle of advance in the "go astern" eccentric than in the "go ahead," so that the engine will have a much longer cut off when going astern, and so develop more power to offset the loss of efficiency of the rounded backs of the propeller blades, and this will also diminish the excessive increase in lead when the engine is linked up.

As a matter of fact, however, no first-class engine builder would turn out a large job in which the eccentrics were not



GAUGE FOR SETTING VALVE.

keyed to the shaft. In Corliss engines the eccentrics are usually held in place with set screws, but in this type of engine the eccentric has little weight to carry and frequently two eccentrics are provided, one for the steam and one for the exhaust. In the case of a marine engine, however, where the weight of gear and valves lifted by the eccentrics often runs up into the thousands of pounds, a good stout key is a necessity. Frequently, indeed, the ahead and astern eccentrics of the gear on each cylinder are secured together by a yoke and bolts, so that the key of the astern eccentric will take a share of the load when going ahead.

The only possible occasion, therefore, on which a resetting of the eccentric would call for an investigation of the valve position would be where an offset key was used, and to meet any such emergency would be a simple matter for a competent engineer who was attached permanently to one vessel and who thus had had opportunity to make a good record of his valves.

Should such a key shear while the engine was running, in case the shaft was not marked so that the sheave could be easily brough back to its proper position, the engineer would reset it with the aid of a gauge such as shown at *A* in the accompanying diagram of a valve spindle and link. The chief use of such a gauge is to determine the wear of the valve gear, and it is made thus: When the engine has been run for a time, after leaving the builders' hands, and when all adjustments have been made to get it to run quietly and efficiently, a center punch mark is made on the bottom of the valve chest and another on the valve stem or valve stem crosshead. The crank is then put on the top and bottom centers and in each position gauges, as shown at *A*, are made touching the center points. The gauge is a piece of round iron, bent and pointed at each end. If at any time the valve gear wears so that the valve gets low, all that is needed to get the valve back into its proper position is to turn the engine over and try the gauges. The difference between the end of the gauge and the center point on the valve stem will show the thickness of liner required to be put under the foot of the eccentric rod.

Referring, however, to the original query of "Mass." in our April issue, in case such a gauge was not at hand and a new key had to be fitted, it would be much more sensible to remove the cover, as this is not a very difficult matter, and the cover could be taken off and replaced long before the key for the eccentric was properly fitted.—Ed.]

Just as we are going to press news is received that the American liner *Paris* is ashore on the Manacles off the Cornish coast on which the Atlantic Transport liner *Mohegan* was wrecked. The mishap occurred about 1 o'clock on the morning of May 21, when the passengers were all in their berths. The vessel lies about 150 yards off shore and is hard and fast on the rocks forward, while her stern is afloat. If the weather keeps good it is probable the vessel will be saved. After the mishap the passengers were conveyed ashore without any accident.

The Spanish cruiser *Reina Mercedes*, which was recently raised in Santiago harbor, where she had lain on the bottom for nearly a year, was towed to Hampton Roads May 22. The vessel will be surveyed, and it is probable that a Congressional appropriation will be made to put her in fighting trim again. The *Reina Mercedes* is a steel cruiser, built at Cartagena, Spain, in 1887. Her dimensions are: Length, 280 ft.; beam, 43 ft.; draught, 16 ft. Her displacement is about 3,000 tons. She is fitted with engines of 4,800 maximum horse power, and has a sea speed at full power of 17 knots. Her armament consists of six 6.2 in. breechloaders and a number of smaller weapons, and she has five torpedo tubes.

It is not generally known, but there was a clause in the Deficiency bill which grants certain officers and enlisted men of the Volunteer Navy who served in foreign waters during the war with Spain two months' extra pay, and officers and men who served in the Volunteer Navy in home waters one month's extra pay. These claims are being rapidly adjudicated, and any claimant who has not yet received his pay should address the Hon. Auditor for the Navy Department, Treasury Department, Washington, D. C. A statement of the applicant's naval service should be made, and his final orders detaching him from whatever vessel he was serving on, together with his honorable discharge, should be enclosed with the claim.

The North German Lloyd passenger and cargo steamer *Barbarossa* left her dock in Hoboken May 18, bound for Bremen. Before she passed out at Sandy Hook fire was discovered in her forehold and she was returned to her dock. In coming up the North river she was forced off her course in avoiding a collision with a ferry boat and she rammed the French liner *La Bretagne*, which was lying at her pier. The French liner was struck on the starboard quarter and cut down to about 2 ft. below the water line. Her moorings broke and she was forced ahead, striking and sinking two ice barges which lay between her and the bulkhead. The *La Bretagne* was moved next day to the Erie Basin dry docks for repairs and her place on the line was taken by another of the French company's ships.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—MATERIALS OF ENGINEERING CONSTRUCTION—IV.

BY DR. WILLIAM FREDERICK DURAND.

(*Concluding Chapter*).

§ 6. LEAD.

Lead is a very soft, dense metal, grayish in color after exposure to the air, but of a bright silvery luster when freshly cut. Commercial lead often contains small amounts of iron, copper, silver and antimony, making it harder than the pure metal. It is very malleable and plastic. In engineering, lead is chiefly of value as an ingredient of bearing metals and other special alloys. Lead piping is also used to some extent for water suction and delivery pipes where the pressure is only moderate, and where the readiness with which it may be bent and fitted adapt it for use in contracted places.

§ 7. TIN.

Tin is a soft, white, lustrous metal with great malleability. Commercial tin usually contains small portions of many other substances, such as lead, iron, copper, arsenic, antimony and bismuth. It is largely used as an alloy in the various bronzes and other special metals. Tin resists corrosion well and in consequence is often used as a coating for condenser tubes. It is also used for coating iron plates, the product being the so-called "tin plate" of commerce. It melts at about 450 deg., which corresponds to a steam pressure of about 400 lbs. per square inch. Due to this low melting point tin is often used as the composition for *safety plugs* in boilers.

§ 8. ZINC.

Zinc, or "spelter," as it is often called commercially, is a brittle and moderately hard white metal with a very crystaline fracture. The impurities most commonly found in zinc are iron, lead and arsenic. It is used chiefly as an alloy in the various brasses, bronzes, etc., and as a coating for iron and steel plates, rods, etc. The process of applying zinc for such a coating is called "galvanizing," and the product "galvanized" iron or steel. Electricity, however, is not used in the process, the articles, after being well cleaned, being simply dipped in a tank of melted zinc and then withdrawn. Slabs of zinc are also used in marine boilers to prevent corrosion.

§ 9. ALLOYS.

A mixture of two or more metals is called an *alloy*. The properties of an alloy are often surprisingly different from those of its ingredients. The melting point is sometimes lower than that of any of the ingredients, while the strength, elastic limit and hardness are often higher than for any of them.

Mixtures of *copper* and *zinc* are called *brass*. Mixtures of *copper* and *tin*, or *copper*, *tin* and *zinc*, with sometimes the substances in small proportion, form *gun metals*, *compositions* and *bronzes*. These terms are, however, rather loosely employed. Various mixtures of two or more of the metals—*copper*, *tin*, *zinc*, *lead*, *antimony*—form the various bearing metals.

Brass and composition are used for piping and pipe-fittings; globe, gate, check and safety valves; condenser tubes and shells; sleeves for tail shafts, and for a great number of small fittings and attachments for which the metal may be suited. The bronzes are employed for many of the uses of brass where more hardness, strength or rigidity are required. They are used with especial success as a material for propeller blades.

The white metals, supported or backed by some other metal, such as brass, cast iron or cast steel, to give the necessary strength, are now very largely used for bearing surfaces.

PROPORTIONS OF INGREDIENTS FOR VARIOUS ALLOYS.

In the following proportions the numbers after the ingredients denote the number of parts in 100 of the mixture. They represent either the usual proportions, or the results of special analyses of samples, and have been collected from various sources. The alloys are arranged in the alphabetical order of their names to facilitate ready reference:

Admiralty Bronze.—Copper 87, tin 8, zinc 5 .

Aluminum Brass.—Copper 63, zinc 34, aluminum 3.

Aluminum Bronze.—Copper 89 to 98, aluminum 11 to 2.

Anti-Friction, A.—Zinc 1, iron .65, lead 78.75, antimony 19.6.

Anti-Friction, B.—Copper 1.6, tin 98.13, iron trace.

Anti-Friction, C.—Copper 3.8, tin 78.4, lead 6, antimony 11.8.

Babbitt (Light).—Copper 1.8, tin 89.3, antimony 8.9.

Babbitt (Heavy).—Copper 3.7, tin 88.9, antimony 7.4.

Brass, Common Yellow.—Copper 65.3, zinc 32.7, lead 2.

Brazing Metal.—Copper 84, zinc 16.

Brazing Solder.—Copper 50, zinc 50.

Bush Metal.—Copper 80, tin 5, zinc 10, lead 5.

Delta Metal.—Copper 50 to 60, tin 1 to 2, zinc 34 to 44, iron 2 to 4.

Deoxidized Bronze.—Copper 82, tin 12.46, zinc 3.23, iron .10, lead 2.14, phosphorus trace, silver .07.

Gun Metal.—Copper 89, tin 8.25, zinc 2.75.

Magnolia.—Tin ?, zinc trace, iron trace, lead 83.55, antimony 16.45.

Manganese Bronze.—Copper 88.64, tin 8.7, zinc 1.57, iron .72, lead .30

Muntz Metal.—Copper 60, zinc 40.

Navy Brass.—Copper 62, tin 1, zinc 37.

Navy Composition.—Copper 88, tin 10, zinc 2.

Navy Journal Boxes.—Copper 82.8, tin 13.8, zinc 3.4.

Parsons White Metal.—Copper 1.68, tin 72.9, zinc 22.9, lead 1.68, antimony .84.

Phosphor Bronze.—Copper 90 to 92, phosphide of tin 10 to 8.

Steam Metal.—Copper 85, tin 6.5, zinc 4.25, lead 4.25.

Tobin Bronze.—Copper 59 to 61, tin 1 to 2, zinc 37 to 38, iron .1 to .2, antimony .30 to .35.

White Metal.—Lead 88, antimony 12.

§ 10. THE TESTING OF METALS.

[1] Different Kinds of Tests.

Metals may be tested for strength in various ways—in *tension*, by pulling apart a test piece of specified pattern and size; in *compression*, by crushing a piece of suitable dimensions; in *cross breaking*, by supporting a bar at two points and breaking or bending it in the testing machine by a load applied at an intermediate point; in *torsion*, by twisting apart a bar in a machine especially designed for the purpose; in *direct shearing*, by breaking a riveted or pin-joint connection in the usual machine; for *impact* or *shock*, by letting a weight drop through a certain height and by its blow develop suddenly the stress in the material.

[2] Explanation of Terms Used.

Ultimate Strength.—The ultimate strength of a test piece is the load required to produce fracture, reduced to a square inch of original section; or in other words, the ultimate or highest load divided by the original area. Thus if the area of the cross-section of a test piece is .42 sq. in. and the load producing fracture is 28,400 lbs., the ultimate strength equals 28,400÷.42=67,620 lbs. per square inch.

Elastic Limit.—The elastic limit is the smallest load, reduced to one square inch of area, which will produce a permanent set or distortion of the material. Thus in a tension test if the cross-section is .68 sq. in. and a permanent elongation or set is just produced by a load of 27,600 lbs., the elastic limit is at 27,600÷.68=40,600.

Elongation.—A certain length being marked off on the test piece as described in [3], [4], the percent-

age of elongation is found by dividing the actual extension of the length just before rupture by the original length, and reducing to per cent. Thus if a length of 8 in. is marked off on the test piece and

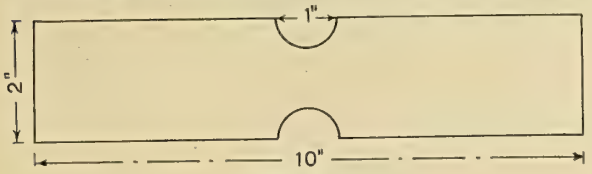


Fig. 1.

if the length between the same marks at fracture is 10.2 in., the actual elongation is 2.2 in. and the per-percentage elongation is 220÷8=27.5%. When a test piece is first put under load the elongation is distributed nearly uniformly over its length. This con-

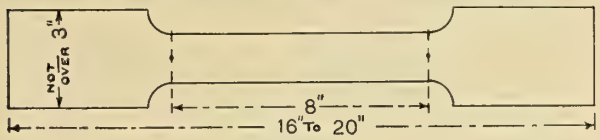


Fig. 2.

tinues until the piece begins to neck down near the point of final fracture. Nearly all of the remaining elongation is restricted to the immediate vicinity of this point. Hence the percentage elongation with a short length of test piece may be much greater than with a long piece. A few years ago, for example, when test pieces 2 in. long were not uncommon, the actual elongation might be nearly 1 in., and thus percentage elongations approaching 50 per cent were

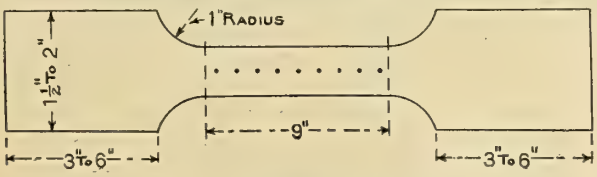


Fig. 3.

found. In modern practice the length of a test piece is usually 8 in. and values of the percentage elongation over 30 per cent even with vastly superior material, are rarely met with. In reporting elongation the length used should always be stated.

Reduction of Area.—The percentage reduction of area is found by subtracting the final area of the section at the point of fracture from the original area at the same point, dividing the difference by the latter, and reducing to per cent. Thus if the original area is .68 sq. in. and the final area is .36 sq. in., the actual reduction is .68—.36=.32 sq. in., and the per centage reduction is 32÷68=47.5 per cent.

For the measurement of the areas of cross-sections,

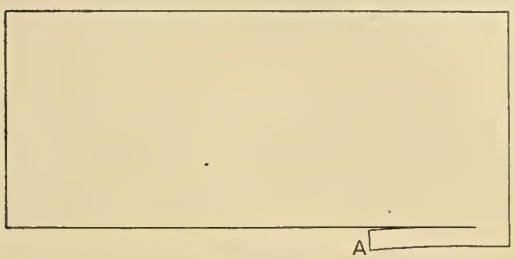


Fig. 4.

especially when of irregular form, reference may be made to Chap. I., §9 [15].

[3] Test Pieces for Iron.

In modern practice the form of test pieces for iron is usually the same as for steel, and as described in [4]. The form of test piece for wrought iron plate prescribed by the U. S. Board of Supervising Inspectors of Steam Vessels is, however, somewhat different, and is illustrated in Fig. 1. If the plate is 5-16 in. thick or less, the width at the reduced section must be one inch. If the plate is over 5-16 in. in thickness, the width of the piece must be reduced so that the cross-sectional area at the reduced section shall be about .4 sq. in., but it must not be greater than .45 sq. in. nor less than .35 sq. in.

[4] Test Pieces for Steel and Other Materials.

Fig. 2 shows the form of test piece for tension pre-

Fig. 5.

scribed by the Navy Department for tests of steel plate for naval uses.

Fig. 3 shows the form prescribed by the Association of American Steel Manufacturers, and adopted by the U. S. Board of Supervising Inspectors of Steam Vessels. The test piece for plates is cut from a "coupon," as it is called, left on one corner of the plate as shown at *A*, Fig. 4. The U. S. law requires further that:

"Every iron or steel plate intended for the construc-

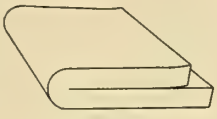


Fig. 6.

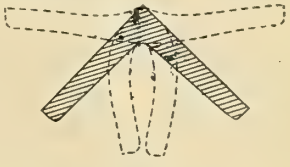


Fig. 8.

tion of boilers to be used on steam vessels shall be stamped by the manufacturer in the following manner: At the diagonal corners, at a distance of about 4 in. from the edges and at or near the center of the plate, with the name of the manufacturer, the place where manufactured, and the number of pounds tensile strain it will bear to the sectional square inch."

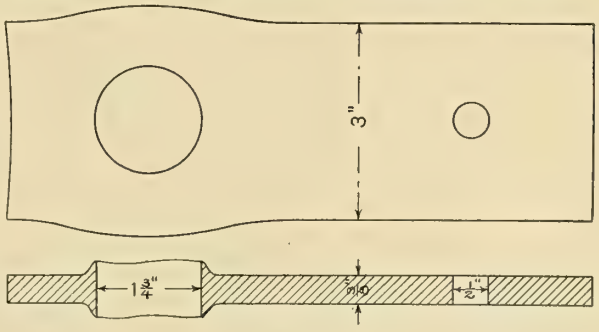


Fig. 7.

Fig. 5 shows the usual round form of test piece for all material except plates.

[5] Bending, Quenching and Hammer Tests.

The nature of these tests has already been described in §5, [5], (11).

Fig. 6 illustrates a cold bending test on a piece of steel plate. A *drift* test is also sometimes required. This is illustrated in Fig. 7, and consists in driving taper drifts of continually increasing size into a punched or drilled hole until the diameter is increased to at least twice its original size. The metal must stand this test without sign of fracture about the edges of the hole.

Bending tests for angle and Tee irons, as described in §5 [5] (11), are also illustrated in Fig. 8.

ELECTRICITY ON BOARD SHIP—PRINCIPLES AND PRACTICE—XVIII.

BY WM. BAXTER, JR.

SAFETY FUSES AND LIGHTNING ARRESTERS.

Field rheostats, which are very commonly called "field regulators," are simply resistances so arranged that they can be cut in or out of the circuit of the shunt field coils of a generator. Generators are always designed to develop the required voltage at a fixed velocity, but as can be readily understood it is not possible to hit the mark exactly, hence if the machine is intended to run at, say, 600 revolutions per minute to develop a voltage of 110, it may, when tried, be found to require a speed of 590 or 610 revolutions. If it requires the latter velocity, all that can be done is to speed it up, but if it will give the desired voltage at the lower speed, then the excess of e. m. f. at 600 can be prevented by inserting in the shunt field circuit a sufficient amount of resistance, and it is for this purpose that the field rheostat is employed. Again, it may not be convenient to run the generator up to the exact speed for which it is designed, or it may be necessary to run it somewhat faster; therefore, if no means of regulating the voltage were provided, the attainment of satisfactory results would not be possible. In order to be on the safe side, generators are always made so that they will develop, at the rated velocity, a voltage somewhat higher than that at which they are expected to run, and then by means of the field regulator the e. m. f. is adjusted to the proper point.

The principle upon which field regulators act is very simple. To illustrate it, suppose we have a generator that develops an e. m. f. of 115 volts when running at the speed that we intend to adopt; then if we introduce resistance in the circuit of the shunt field coils, the current passing through these will be cut down and, therefore, the magnetism will be reduced and thus the voltage lowered. Let us suppose that the shunt coils have a resistance of 50 ohms, then if we desire to reduce the e. m. f. from 115 to 110 we will have to increase the resistance of the circuit enough to cut the current down about five per cent. As a matter of fact we will have to reduce the current more than five per cent, owing to the fact that the magnetism will not reduce in the same proportion as the current; but for the sake of an illustration we can suppose that the current and the magnetism will reduce at the same rate. Now as we have to reduce the current about five per cent, we must increase the resistance in a corresponding amount; therefore as the resistance of the shunt coils is 50 ohms, we will have to add about two and a half ohms, thus increasing the total resistance to 52.5 ohms.

The foregoing calculation is based, as we have stated, upon the assumption that the magnetism and the field magnetizing current change in the same proportion, but in reality the magnetism reduces much slower than the current strength, and the difference between the rate of reduction of the two depends, in part, upon the character of the iron of which the field is made, but principally upon the degree to which the field is magnetized. If the magnetization is very strong, a reduction in the strength of the field current of 10 per cent may not reduce the magnetism more than two or three per cent. On this account, the amount of resistance introduced in the field rheostat has to be much larger than would be supposed at a first glance. As a rule the field rheostats have a resistance of from 20 to 50 per cent of the shunt coil resistance.

Field rheostats can be made of anything that offers resistance to the passage of an electric current, and that at the same time is of such a nature that it can be put into a mechanical and durable form. The most commonly employed substance is wire, generally iron or German silver. In most cases the wire is wound in the form of coiled spring and is then stretched out sufficiently to separate its turns from one another.

A simple form of field regulator is shown in Fig. 101. The apparatus consists of a box *F*, which can be made of any suitable material, wood, sheet metal, cast iron, etc. In former days wood was very commonly used, but at the present time in the most generally used construction the sides of the box are made of cast iron and the back of sheet iron, the object of using metal being to render the box fire proof. The way in which the coils are held in place is clearly shown in the figure, and it may only be necessary to add that the double bottom and top are provided so as to cover the connections of the ends of the several coils, and thus not only make the structure more mechanical in appearance, but also more substantial, as the connections are guarded against injury, and are not liable to be touched by the attendant.

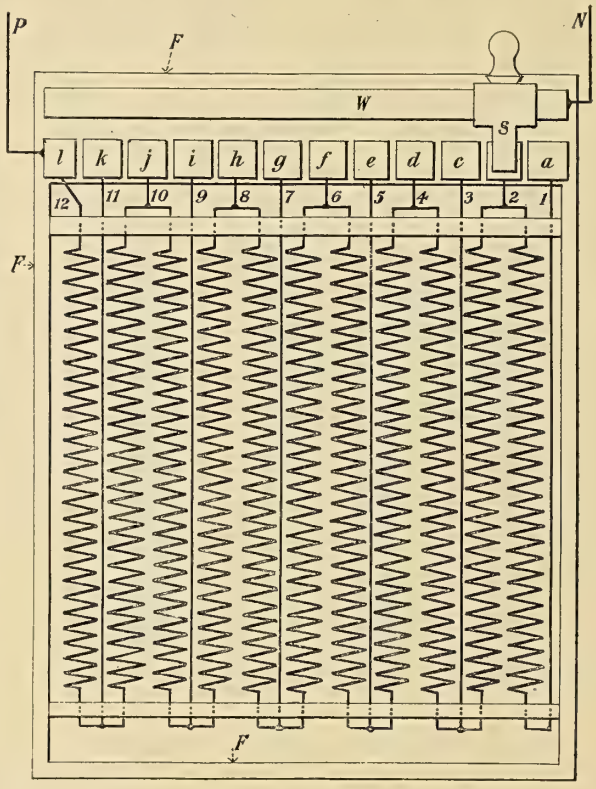


FIG. 101.

In connecting the box in the shunt field circuit, the latter is opened at any convenient point, and the ends are connected with the wires *N* and *P*. As will be seen *N* is connected with a bar *W* and *P* with block *l*. The connection between *W* and *p* is effected by means of the switch *S*. When this switch is placed upon block *a* the current will have to pass through all the wire coils before it can reach block *l*, hence, all the resistance of the apparatus will be in the circuit. If *S* is moved ahead so as to rest upon block *b*, the current will enter the resistance coils through wire 2 and thus cut out the first coil. As the switch *S* is advanced, from block to block, coil after coil will be cut out and when block *l* is reached all the resistance will be out of the field circuit. From this explanation it can be seen that the amount of resistance inserted in the field circuit can be adjusted by the position of the switch *S*.

The position where *S* must be left is determined by the voltage of the current, therefore the field regulator should be placed in such a position that its switch

handle can be moved while the attendant is looking at the dial of the voltmeter. If the voltage is too high, *S* is moved back toward *a*, and if the voltage is too low, *S* is moved forward, towards *l*. When the proper voltage is obtained, the switch is in the proper postion and is allowed to remain there.

The design of field regulator shown in Fig. 101 is

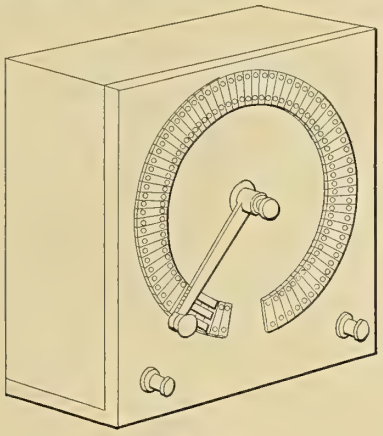


Fig. 102.

very seldom used in actual practice, as it is inferior in many ways to the design shown in Figs. 102 and 103, which are illustrations of well known types of field regulators in common use. We have employed the design of Fig. 101 to explain the construction and principle of action of the device, as it shows more clearly the circuit connections than the construction of Figs. 102 and 103. It can be readily seen, however, that the switch *S* will not move as freely as the

Fig. 103.

rotating arm of Figs. 102 and 103, and furthermore, if we used the same number of contacts *W* would have to be made about twice as long as the width of the entire box in Fig. 103. In Fig. 101 only twelve contacts are shown, for the sake of simplicity, but in actual rheostats, the number is much greater, as shown in Figs 102 and 103. A great number of contacts is required so as to obtain close adjustment of the voltage, upon the same principle that many weights are required to weigh with accuracy. If we had a balance scale and ten one-pound weights, we would not be able to determine the weight of anything closer than a fraction of a pound, for if it weighed more than, say, four pounds, it would be underbalanced with four of the weights and would be overbalanced with five. If, however, we had 160 one-ounce weights, we could determine the weight to within less than one ounce. If we had a field regulating rheostat with ten contacts, we could not set the switch so as to obtain a voltage as near to the desired point as with a greater number of contacts. As an illustration, suppose we desired to obtain a voltage of 110 and that we found that by cutting in five sections of the rheostat we could get 112. We would then cut in another section, and this might cut the voltage down to 108, and we would be powerless to effect a closer adjustment except by varying the speed of the generator. If, however, we had a regulator with forty contacts, we could obtain three different voltages between 112 and 108 and one of these might be very near to the 110 mark, say 110.5 or 109.5. Thus it will be seen that the object of providing a great number of contacts is to provide means whereby the voltage may be adjusted nearer to the required standard.

The field regulators made for small generators may have not more than twenty contacts, while those for very large machines may have as many as eighty or one hundred, the average being between forty and fifty.

Rheostats made of wire coils suspended in the air, as shown in Fig. 101, are rapidly giving away to those of more compact form, such as shown in Figs. 102 and 103. The advantages of these designs are not only that the space occupied by the apparatus is reduced, but also that they are more durable. Fig. 102 is what is known as an "Enameled rheostat." It consists of one or several cast iron plates upon which fine iron wire is attached by means of a coating of enamel. The iron is first coated with a layer of enamel and then the wire is placed upon this and is covered with a second coat. The wire being embedded in the enamel is protected from the action of the air and therefore can be heated to a high degree without danger of becoming oxydized, and on this account much smaller wire can be used than in rheostats of the type shown in Fig. 101.

The rheostat shown in Fig. 103 is made of rods of carbon, which are supported by means of insulating material. This type of rheostat can also be made smaller than Fig. 101, as the carbon rods can withstand a much higher heat than the bare iron wire. In all types of rheostats the part that forms the resistance must be well insulated from the supporting frame. In Fig. 101, if *F* is made of wood, the wires can be run through holes bored therein, the wood itself being sufficient insulation providing it is saturated with varnish, so as to make it water proof; if the frame *F* is of metal, porcelain bushings are inserted in all the holes through which the wires pass. In Fig. 102 the wire is insulated from the frame by means of the enamel, and in Fig. 103 the carbon rods are insulated from the frame by means of fire proof insulating material.

Safety fuses are sometimes used upon switch boards, but as a rule their use is confined to other parts of the circuit. A safety fuse serves the same purpose as a circuit breaker, but its action is not so reliable. The principle of safety fuses can be understood from Fig. 104. If the terminals *a b* of the wires

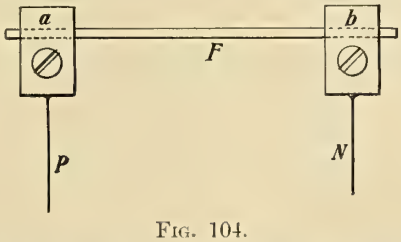


Fig. 104.

P N are connected with each other, by means of a rod *F*, a current will pass from *a* to *b* through the rod, and if the latter is made of smaller size than *P* and *N* it will melt, if the current strength is increased, before the latter will. If *F* is very much smaller than *P* and *N* it will be melted by a current that is not strong enough to heat the latter to any noticeable extent. When *F* is given this proportion it becomes a safety fuse, as it will melt and thus open the circuit before the current becomes strong enough to injure *N* or *P*. The fuse *F* can be made of any kind of wire, the only requirements being that it be so pro-

portioned that it will melt before the current becomes so strong as to overheat other portions of the circuit. As a rule fuses are made of alloys of lead, tin and bismuth that melt at low temperatures and with a much weaker current than the same size copper wire can carry with safety. In warm weather a fuse will melt with a weaker current than in cold weather, hence they are not as reliable as a circuit-breaker. A circuit-breaker will fly open as soon as the current reaches a certain strength, but a fuse will not melt until the current has had time to heat it to the melting point, hence, the former is a better protection against a sudden increase in current strength, the latter only acting when the current continues of increased strength for some time. When fuses are used in switchboard work, they are placed on the back of the board.

Lightning arresters are sometimes used on switchboards, but, as a rule, they are located at other points in the circuit. Lightning arresters provide a path around the apparatus in the circuit that they are intended to protect, so that the discharge may pass to ground without doing damage. The principle of construction can be explained in connection with Fig. 105, which shows one of the simplest forms. *A* is a

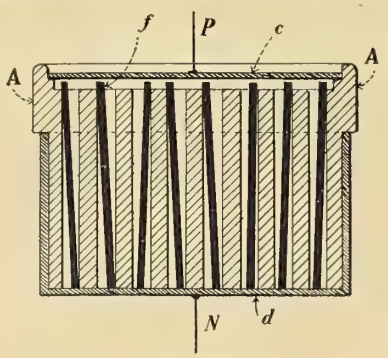


FIG. 105.

porcelain cylinder, made with a number of holes, into which are dropped pieces of fuse wire *f*. The wire *P* is connected to a copper plate *c*, and *N* connects with a copper cup *d*. The fuses are generally of such length that they come within about one-sixteenth of an inch of the plate *c*. When a lightning discharge reaches *c* it will jump to one or more of the fuses *f*, on account of its enormous e. m. f. The generator current, of itself, cannot jump across this space, but if the current is carried over by the lightning, then the generator can keep up the flow and thus become short circuited. But the generator current will not flow many seconds before the fuses will melt and open the short circuit. All lightning arresters are so made that if the generator current follows up the lightning discharge, they will open the circuit to ground formed through them. Fig. 106 shows one of the best known types of lightning arresters, called the magnetic blow-out arrester. In this device the lightning discharge jumps across from the lower corners of the light-colored plates shown at the top of the magnet, these plates being very close together at this point. If the generator current follows the lightning it energizes the magnet, and the magnetic lines of force push the arc formed by the current to the top of the plate, where the distance is so great that the current breaks.

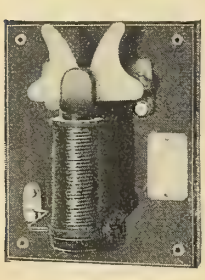


FIG. 106.

At the Morris Heights, N. Y., shipyard the new steam yacht *Kanawha* for John P. Duncan, of New York, was launched May 27. She is 192 ft. long.

ENGINEERS' DIRECTORY—XVII.

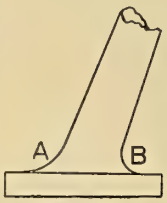


FIG. 73.

Fillet.—Where a piece of metal suddenly changes its shape or size it is always desirable to fill in the corner between the two parts, thus connecting one part with the other by a corner rounded or concave rather than square. This furnishes a relatively easy change from one size or shape to the other and decreases the likelihood of a crack or failure at the angle. The filling in at such a corner is known as a *fillet*, and is illustrated at *A* and *B*, Fig. 73.

Fire Box.—A kind of boiler furnace of nearly rectangular or box-shaped form. The term is more commonly used in referring to the *fire-box* type of boiler. See under *Boiler*, Fig. 7.

Fire Bridge.—See under *Boiler*, Fig. 6.

Fire Clay.—The clay of which fire bricks are made. A good fire clay should have a composition about as follows:

Silica	50 to 60
Alumina	20 to 30
Fluxing constituents	2 to 3
Water	remainder in 100 parts

Fireman.—One of the engineer's force whose duty it is to care for and regulate the fires. His duties consist chiefly in throwing the coal evenly upon the fires and in cleaning them and removing the ashes, all at regular intervals. In British practice the term *stoker* is usually employed.

Fire Room.—The space in front of the boilers from which the fires are worked. Also called *stoke-hold.*

Fires.—The burning fuel on the grates. For *banked fires* see under *banked.* To *haul* fires means to pull the burning fuel from the furnaces out upon the fire-room floor, leaving the grates bare. To *spread* fires from the *banked* condition means to spread the fuel evenly over the grates, add fresh fuel as may be needed, supply the proper draft, and bring the fires into an active condition.

Fire Tools.—The tools with which a fire is cleaned and kept in order. The usual tools are as follows: *Slice bar*, large and small; *pricker bar*, large and small; *hoe* and *shovel.* The slice bar is straight, with a slightly flattened or triangular pointed end. It is used to run in on the grate and underneath the fire in order to break up the clinker formation, and to free the fire from the grate and give the air a better chance to penetrate the fire. The large pricker bar, which is similar in form to the ordinary poker, is sometimes used for the same purpose. The small pricker is used to clear out the grates from the ash pit without opening the furnace door. The hoe is used for hauling and banking fires and for pulling the ashes from the ash pit, while the shovel is used to handle the coal and ashes.

Fire Tube.—A boiler tube in which the fire or hot gas is on the inside and the water on the outside.

Fire Tube Boiler.—A boiler in which the tubes have the fire or hot gas on the inside and the water on the outside. See *Boiler.*

Flange.—A ring or fringe of metal standing usually at right angles to the main piece to which it is attached or of which it forms a part, and serving for the attachment of other members or parts. Thus a boiler head is flanged for the attachment of the shell and the furnaces. (See *Boiler*, Fig. 6.) The cylinder barrel has a flange to which is attached the cylinder cover. (See *Engine*, Fig. 54.) Two pieces of shaft are connected by a flange coupling, as shown under *Coupling*, Fig. 38.

Flanged Joint.—A joint made by the use of flanges, often with some form of fibrous or sheet packing between.

Float.—The acting part of a paddle wheel. Floats are of two kinds, *feathering* and *radial* or *fixed.* For

a description of the former see under *Feathering*. Radial floats are rigidly attached to the arms of the wheel, as shown in Fig. 74. Radial or fixed floats are usually made of wood, feathering floats of either wood or steel plate. The term float is also used in its general sense to denote any part of an apparatus

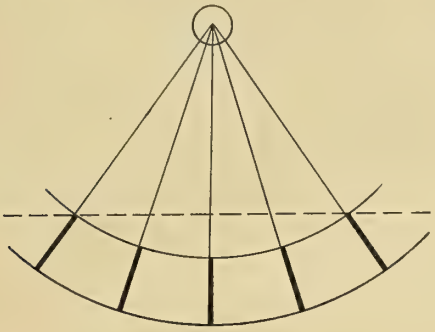


Fig. 74.

which floats partially submerged in a liquid, thus serving to show its level, or to perform some desired operation as it rises and falls with varying level, as in certain forms of steam trap, automatic feed controller, etc.

Flue.—A portion of a boiler cylindrical in form and containing hot gas and surrounded with water, and differing from a tube simply by reason of its size. Flues are usually from 6 in. to 8 or 10 in. dia., while tubes are from 2 to 3 or 3 1-2 in.

Flush Head Bolt or Rivet.—See under *Countersunk*.

Foaming or Priming.—A disturbed condition of the water in the boiler, of such a nature that the water level is more or less uncertain in location and the steam space is partially filled with foam or a mixture of foam and water. In severe cases of foaming steam seems to be given off from almost the entire mass of water in the boiler, causing it to rise bodily as foam and water and fill the whole steam and water space, thence entering the steam pipe and passing on to the engine. In other cases the water seems occasionally to rise in gulps, nearly unmixed with steam, and entering the steam pipe, pass on to the engine. The terms *foaming* and *priming* are often used as meaning practically the same thing. Where a difference is implied foaming is understood to apply more especially to the uplifting of the mixed steam and water as foam, while priming may refer more particularly to the lifting of water as such and its passage over into the engine. There is, however, no clear line of distinction between the two kinds of disturbances, and there are all grades intermediate between the extremes. Foaming may be due to the presence of certain forms of oil or grease or other impurities in the water, or to a demand for steam too large in proportion to the steam space in the boilers. A sudden change in the character of the feed water may also produce foaming. In former days, when jet condensers were in common use, boilers were liable to foam in passing from sea water to fresh water, especially if the latter was muddy, and again in passing from fresh water back to sea water. In modern practice foaming is usually due either to the presence of oil or to an extreme demand for steam from the boiler. In the former case the oil must be removed by a free use of the surface blow and kept out by a proper filter. In the latter case the engine must be slowed and the demand for steam reduced to an amount which the boilers can supply without the danger of such disturbance. As the result of foaming the engine slows down, power and speed are lost, while due to the possible inability of the relief valves to handle all of the water coming into the cylinders, there may be serious danger of breakdown. There is also danger to the boiler in foaming, because the water level cannot be known with any certainty, and plates or tubes may become overheated, resulting possibly in collapse with serious consequences. The tendency to foam is, therefore, a symptom of serious import, and no steps should be neglected to discover, and, if possible, to remove the cause.

Follower or Follower Plate.—The ring or plate which holds the packing rings of a piston in place.

Follower Bolts.—The bolts which secure the follower to the piston head. For this purpose *stud* bolts are always used. See under *Bolt*.

Foot Valve.—In general a check valve in the suction passage to a pump. It is more particularly used in reference to a valve at the bottom of the air pump cylinder, or between the condenser and the cylinder. See *Air Pump*, Fig. 2. *C*.

Forced-draft.—Draft which is forced or urged, usually by fans or blowers, beyond what would be given by the funnel alone. With the latter alone the draft is usually known as *natural*, or *stack* draft. While there is no sharp line of separation between *natural*, *assisted* and *forced*-draft, the latter is usually considered as meaning a draft pressure of from 1 1-2 or 2 in. of water upward to 5 or 6 in. (See under *Air Gauge*). Occasionally, however, the term is used as implying simply a mechanically assisted draft, giving a pressure of from 3-4 in. of water to 1 or 1 1-2 in.

There are four fairly distinct systems of forced draft: (1) closed fire-room, (2) closed ash-pit, (3) exhaust blowers between the uptakes and funnel, (4) steam jets in base of funnel.

In the close fire-room system the air is forced by means of blowers into the fire-room, which is closed air-tight except for the outlet into the furnaces. The chief advantages of this system lie in the fact that the boilers are left unchanged as for natural draft, and the shift from one system to the other is readily made. The necessary structural arrangements are also sometimes more readily effected than for the other systems, especially in warship practice, and this reason may in some cases largely determine the choice. Its chief disadvantages lie in the difficulty of making the fire rooms air tight, in the necessity of fitting *air-locks* (see under that term) for entering and leaving the fire-rooms, and in the more severe strain placed on the fire-room force than with the other systems.

In the closed ash-pit system the air is forced by means of blowers into conduits leading directly to the ash-pits and furnaces. The *Howden forced draft*, which is representative of this system, involves also as a fundamental feature the heating of the air by means of the waste furnace gases before it enters the ash-pits and furnaces. This method requires the fitting of special ducts from the blowers to the ash-pits, of suitable passages for admitting the air on top of the fire through the inner furnace door lining, and also of a special arrangement of uptake with a nest of vertical air-heating tubes through which the waste gases pass, and around which the air passes on its way to the ash-pits.

Induced draft is represented by the *Ellis and Eaves* system, in which a large exhaust fan is so placed as to draw the gases along the uptakes and discharge them to the funnel, thus producing the draft by means of a defect of pressure in the uptakes, rather than by an increase in the ash-pit or fire-room. The air which in this case is supplied either by natural ventilation or by special blowers is heated before reaching the furnaces by being drawn through or around tubes, around or through which the furnace gases pass on their way to the fan. The chief disadvantage of the induced system lies in the large size and weight of fan necessary to handle the gases, as compared with the much smaller size needed for the air alone in the other systems. The two latter systems with the air heating feature, however, have proved very successful, and have shown that fairly high rates of combustion may be reached (20 to 30 lbs. per sq. ft. of grate surface) without undue loss of economy, and even in some cases with actual gain

over the results of much lower rates of combustion under ordinary methods.

The installation of these systems requires great care and an accurate knowledge of the conditions to secure the proper results.

The action of a steam jet in the base of the funnel is to produce a defect of pressure in the uptake, thus giving a form of induced draft. Turning the exhaust of a non-condensing engine into the funnel produces the same result, and may be considered also as giving a form of induced draft. The latter arrangement is sometimes met with in tugs and other small craft, while the steam jet is much used throughout the whole range of tugs, yachts, launches, tenders and all forms of small craft. One of the special advantages of the steam jet is its readiness for use as soon as a small head of steam is formed, and independent of the operation of the main engine.

During the past few years there has been a great extension in the use of forced draft in the mercantile marine, either the *Howden* or *Ellis and Eaves* system being usually fitted, on account of the excellent showing in economy which they have made.

Fork.—A rod made at one end into a Y or U shaped form. See under *Eccentric Rod Fork*, Fig. 52.

Forked Connecting Rod.—A connecting rod formed into the U shape at the upper end. See under *Connecting Rod*, Fig. 35.

Foundation or **Foundation-Plate.**—A term having about the same meaning as *Bed-Plate*, which see The term *foundation* alone is also sometimes used in reference to the specially strengthened structure of the ship under certain parts of the machinery, as, for example, the main engine or the thrust bearing. The term *seating* is, however, more commonly used in referring to this structure.

Front-Connection.—In a return fire-tube boiler, the passage leading the gases from the front ends of the tubes to the base of the funnel. This passage is more generally known as the *uptake*, or, if a distinction is to be made, the latter term refers to the passage as a whole, while the term *front-connection* may be used in particular reference to the lower part of this passage, or that part immediately in front of the boiler. See under *Boiler*, Fig. 6.

Front-Connection Doors.—Doors swinging upward and occupying practically the entire front of the front-connection. Their purpose is to allow examination of the front-tube sheet and tubes, and provide access to them for cleaning and repairs.

Funnel; *Smoke-Stack* or *Smoke-Pipe.*—The passage through which the gases and smoke coming from the uptakes are led to the outer air. In natural draft the use of the funnel is to provide a column of relatively hot gas. The draft pressure is then the difference in weight between a column of hot gas of cross-section one square inch and of height equal to that of the funnel above the grates, and the weight of a similar column of outside air. The funnel is usually circular in section, and extends to a height of from 50 to 80 or 100 feet above the furnace grates. Funnels usually made of double thickness, sheet steel, with an air space between, the better to prevent radiation and loss of heat, and a cooling of the gases before they have reached the top. Occasionally the funnels are of elliptical or oblong section, in order to oppose less air resistance to the motion of the ship. The cross-sectional area of the funnel should be from 1-7 to 1-9 of the grate surface, or slightly less than the cross-sectional area through the fire-tubes.

Funnel Cover or **Hood.**—A cover placed over the top of the funnel when the ship is laid up for any length of time.

Funnel Guys or **Stays.**—Guys or stays, usually of wire rope, for supporting the funnel in place. They run from the top or upper part of the funnel to the deck or rail of the ship.

Furnace.—The part of the boiler which contains the burning coal, and from whence the hot gases pass to the tubes. See under *Boiler*.

RECENT PUBLICATIONS.

THE SLIDE RULE. By Charles N. Pickworth. D. Van Nostrand Co., New York. Fifth Edition. Size 5 by 7 1-2. Pages 88. With illustrations. Linen covers.

This is one of the clearest expositions of slide-rule practise within the reviewer's ken, and should meet with a hearty welcome from students and practical workers. The language is unaffected and the explanations are concise and direct as well as lucid. The text is logically arranged; an explanation of the mechanical and mathematical principles of the slide rule precedes a description of the Mannheim rule and an explanation of its notation. This is followed by a table of conversion factors and instructions in the practical use of the slide rule, the latter including copious numerical examples. A short discussion of circular calculators of the watch (Boucher) and long-scale types and special rules for limited application completes the book.

Lean's Royal Navy list has completed the twenty-first year of its existence, during which time it has steadily grown in the confidence of those who seek accurate information in its pages. It is issued quarterly, and the latest issue, now before us, is divided into chapters containing: Seniority list of all British naval and marine officers on the active and retired lists; lists of all the vessels of the British Navy, giving officers and station; lists of officers of the Royal Naval Reserve, and naval officers at the shore stations, and a complete record of war services, rewards, etc., of officers on the active and retired lists of the Royal Navy and Royal Marines. For those who require information on the subjects mentioned, this publication is indispensable. The publishers are Witherby & Co., 326 High Holborn, London, W. C., and the selling price is 7s. 6d. per copy, or £1 7s. 6d. annually in advance.

The prospectus for the twenty-fifth volume of the Proceedings of the U. S. Naval Institute contains a number of extremely interesting papers which will be published during the coming year. Among those treating of war subjects are: "Cable Cutting Operations During the Spanish War," by Capt. C. F. Goodrich, U. S. N.; "The Battle of Manila Bay," by Lieut. C. A. Calkins, U. S. N., and "The Location of Cervera's Fleet," by Lieut. Victor Blue. No. I. of this volume contains much exceptionally interesting matter concerning the Spanish-American War. Copies can be ordered from the Secretary and Treasurer, U. S. Naval Institute, Annapolis, Md. Single copies are $1 each and the annual subscription for non-members is $3.50.

Captain Henry A. Bourne, president of the Old Dominion Steamship Co., died at his residence in Brooklyn late in April, aged 70 years. He had followed the sea all his life, and at the close of the Civil War he entered the service of the Old Dominion Steamship Co. as Captain of the steamship *Albemarle*. He was thereafter master of various vessels owned by the company, and in 1876 was appointed general superintendent. Later he was made general manager, and then in succession he was elected vice-president and president of the company. Those who knew him best speak of him with admiration, and his reputation among those interested in marine affairs as a liberal, sympathetic and upright man was widespread. To his executive ability the splendid daily services of the company bear witness. The vacancy caused by his death has been filled by the unanimous action of the board in the election of William L. Guillaudeu, for many years vice-president and general manager. This is a well earned honor, as Mr. Guillauden has been in the service of the company since boyhood. He has filled every position in the office of the company where ability and a steady attention to duty were demanded, and his final advancement is the capstone to an honorable business career.

TRADE PUBLICATIONS.

Users of fire hose who have not been satisfied with the quality of the hose used will take a hint from a circular issued by the Boston Belting Co., 256 Devonshire street, Boston, Mass.

A new line of grate bars is just being offered and is illustrated in a circular issued by the manufacturers, Neenes Bros., Troy, N. Y. These are designed for either soft or hard coal. The type of the grate is illustrated in the circular.

The Jennings combined steam separator, also reducing valves and other steam specialties, have a catalogue devoted to them, issued by Watson & McDaniel Co., Philadelphia, Pa. Each specialty is thoroughly illustrated and described.

Portable bellows forges is the subject matter of circular *B*, issued by the Crumlish Forge Co., Buffalo, N. Y. The portable forge is illustrated and a brief description given, together with a number of testimonials from shipbuilders and others.

A neat folder which, when opened up showing a number of yachts sailing before a stiff breeze, illustrating Lundell fan motors, is a souvenir for which all interested will wish to send for to the Sprague Electric Co., 20 Broad street, New York.

The Gumphert grate is a recent invention offered by the Gumphert-Marrin Engineering Co., 302 Chestnut street, Philadelphia, Pa. It is a type of grate which has been much used in marine work, and sectional drawings and other engravings are given, showing the application.

Centrifugal pumping machinery manufactured by the Kingsford Foundry & Machine Works, Oswego, N. Y., is described in a very neatly printed and illustrated catalogue devoted to them. Besides a description of the various types of pumps, there are price lists, speed and other tables which are of much interest.

A new brand, "High Grade" yellow metal bolts, sheathing and plates, is offered by the U. T. Hungerford Brass & Copper Co., 121 Worth street, New York. Shipbuilders and others who are users of these specialties will find these circulars of much interest, especially as they give a list of many other brass and copper goods manufactured by this company.

A large pamphlet has been issued by the Daimler Motor Co., Steinway, Long Island City, N. Y., giving many testimonials of the excellence of launches and engines manufactured by this company. These letters will be well worth perusal by any of our readers who contemplate purchasing an engine or launch, as the letters come from all parts of the country.

The subject of graphite for lubricating gas engine cylinders, valves, pistons and other small or close-fitting bearings is well discussed in a four-page circular issued by the Joseph Dixon Crucible Co., Jersey City, N. J. The subject is handled in such a manner that all who read the circular will wish to send for the larger pamphlet entitled "Graphite as a Lubricant."

Lundell fan motors are superbly illustrated in one of the the most handsome catalogues we have received, issued by the Sprague Electric Co., 20 Broad street, New York. It covers the subject very thoroughly and the illustrations are exceptionally fine. Attention is also given to the small exhaust fans. Copies can be had by referring to MARINE ENGINEERING.

The hydraulic steering engine and duplex steam pumps manufactured by the Queen City Engineering Co., Buffalo, N. Y., are illustrated and described in considerable detail in a pocket-size catalogue just issued. Other subjects referred to are boiler feed pumps, tank pumps, single-cylinder high pressure pumps, etc. Copies of the catalogue can be had from the company upon application.

Propeller wheels of the "perfected outward thrust" type, as designed and manufactured by A. Wells Case & Son, Highland Park, Conn., have a very well-printed and thoroughly illustrated catalogue of nearly 100 pages devoted to them. Many testimonials are given; also many pictures of yachts and other vessels. Copies of this catalogue can be had by any of our readers by writing for them and mentioning MARINE ENGINEERING.

A catalogue is sent free to all inquirers by the Boston & Lockport Block Co., 142 Commercial street, Boston, Mass., descriptive of this company's blocks and other marine specialties. The catalogue is very complete, and each article is illustrated and accompanied by full information. Any one who has need for specialties of this kind will find this catalogue particularly valuable for reference, especially for the large list of subjects it covers.

Blue printing apparatus of all kinds is fully described in circulars and cards issued by the F. W. Emerson Mfg. Co., 27 Mortimer street, Rochester, N. Y. The latest card issued shows a large printing frame on a car for easy handling, and other specialties. These cars and frames have recently been supplied in large numbers to the United States Government and to many prominent engineering concerns; also many large detail tables, of which this company makes a specialty.

A circular from the Taunton Locomotive Mfg. Co. regarding the Wainwright appliances gives information regarding the opening of the New York office in the Singer Building, under the management of Charles H. Paine. The latest catalogue, *E*, is now ready, containing illustrations and full information regarding the Wainwright feed water heaters, surface condensers and expansion joints. Copies of this catalogue can be had from the home office in Taunton, Mass., or from Mr. Paine.

Electric fans made by the Diehl Mfg. Co., Elizabethport, N. J., have a very attractive catalogue devoted to them. These fans include ceiling and column fans, brackets, ventilating fans, etc., all of which are illustrated and have much descriptive matter devoted to them. This company has recently begun the manufacture of a direct connected electric plant, the general type of which is shown in the advertisement elsewhere. Fuller information can be had by applying to the company.

Rolled steel floor plates for floors and steps in engine rooms are well illustrated and described in a catalogue issued by Taylor & Lewis, Lewis Building, Pittsburg, Pa. It is claimed in the catalogue for these plates that steel has advantages over cast iron in that it is much lighter and stronger and quite impossible to break under ordinary stress. Should it be bent it can be readily straightened. The subject is one that will interest many of our readers, and copies of the catalogue can be had upon application.

Pipe Threading Machines.—Marine engineers and those in charge of machine and repair shops, whether ashore or afloat, will be interested in the catalogue recently published by the Merrell Mfg. Co., Toledo, Ohio, concerning their pipe threading and cutting machines. In the advertisement, this company illustrates its No. 5 portable hand machine. On this, power is applied by either crank or ratchet lever to the shaft of the pinion, which engages the geared wheel enclosing the dies. The gears are completely housed from dust and chips. These machines have the Standard adjustable quick opening and closing die head and improved cutting-off knife. The chasers are five in number on Nos. 5 and 6 machines and six on No. 9. They are set by graduation to any size desired, are released from threading while in motion, opened to permit the pipe to cut off and closed instantly and positively, one set being used to thread several sizes of pipe. These are only a few desirable features of this machine, which is described in full by catalogue, copies of which can be had upon application by mentioning MARINE ENGINEERING.

Song of the Canalman.

The battleship's majestic bow,
May plough the stormy main;
The ocean greyhound's iron prow
May cleave the sea in twain;
Yet I'd not give my little ship
For any in the bay:
Come to me in Coentie's slip,
Where lies the Maggie May.

The Maggie May is long and lank,
Her engine is a mule;
I keep her gunnels close to bank,—
Her rudder feels my rule.
In summer, when the warm winds blow
Across the new-mown hay,
I sail to far off Buffalo
Upon the Maggie May.

But winter finds us here again,
In old Coentie's slip.
My cabin is the snuggest den
That e'er adorned a ship,
With lockers full of meat and pie
To nibble night and day;
And 'near the bunk, a jug of rye—
Long float the Maggie May.

But I've been thinkin' some of late,
'Bout makin' other plans;
In fact I need a good first-mate
To wield my pots and pans;
To bake my bread—my salt-hoss fry;
Who will not say me nay?
If there be such, she may apply
To me and Maggie May.

—*George A. Beckenbaugh.*

BUSINESS NOTES.

INCREASED FACILITIES.—The Frasse Co. has recently removed from 19 Warren street to 38 Cortlandt street, New York, in order to secure more facilities. This company carries a full line of tools for machinists and engineers.

MARINE GLASSES.—One of the largest stocks of marine glasses in the country is carried by the Spencer Optical Mfg. Co., 15 Maiden Lane, New York. This company also has the sole agency for the Andemair's field and marine glasses. Circulars and information regarding any of the goods handled by this company can be had upon application.

THE SPEDDEN CO.—The Spedden Co., Baltimore, Md., is busier than at any time in its history. One of the latest reports stated that that there were six tugs and steamers at the yards. Besides this work the company was recently awarded a contract for a dispatch boat by the Government, and recently received a contract to rebuild the S. S. *Bluefields*.

TOOLS.

Fine Mechanical Tools.

Gear and Milling Cutters.

112 Page Catalogue Free.

N. Y. Office, 126 Liberty St.

THE L. S. STARRETT CO., Box 99, Athol, Mass.

REDUCING VALVES

to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Write for prices.

THE MASON REGULATOR CO.,
BOSTON, MASS.

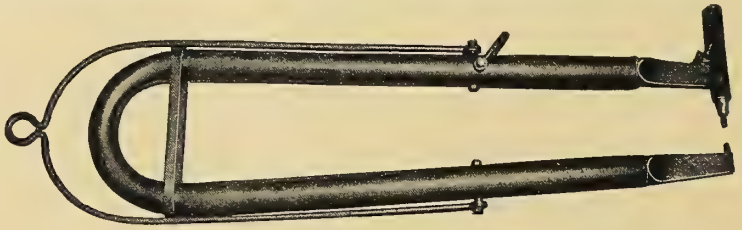
PNEUMATIC RIVETERS

FOR STACK, TANK, AND ALL KINDS OF STRUCTURAL WORK.
Made up to 7 ft. gap and will drive from ⅜ in. to 1¼ in. rivets.

THE Q AND C

SEND FOR CATALOGUE.

CHICAGO,
NEW YORK.



Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

Largely increases the lubricating value of all oils or greases.

Will cool bearings and stop "groaning" or squeaking when all other lubricants fail.

It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N.J.

GARLOCK PACKINGS.—The Garlock Packing Co., Palmyra, N. Y., commenced business in a small way, nearly a quarter of a century ago, with one fixed principle in view, namely, that all of its productions should be of a superior quality. From the fact that the business has doubled every year from the commencement, it is self-evident that the goods have met with favor among engineers. Their annual output now numbers many thousands of tons.

BOILER COMPOUND.—The subject of keeping marine boilers free from incrustation and galvanic action has led to the establishment of a special department by the Dearborn Drug & Chemical Works, Rialto Building, Chicago, Ill., under the charge of E. P. Gould, a well-known lake engineer. The subject has been carried out in detail in its application to steamboat service on the Great Lakes, but has only recently been extended to the salt water service. Circulars and other information regarding this new departure can be had upon application to Mr. Gould, care of the company.

CHANGE IN NAME.—Owing to a recent decision of the court the Lee-Penberthy Injector Co., Detroit, Mich., has dropped the name Penberthy, and will hereafter be known as the Lee Injector Mfg. Co., and the injectors will be sold as the Lee.

FREE SAMPLES.—The seam composition for filling cracks and checks in masts, beams, rails, etc., manufactured by Cole & Kuhls, foot of Twenty-fourth street, Brooklyn, N. Y., has been thoroughly tested on yachts and vessels for many years, and in order to increase its use the manufacturers offer to send free samples to anybody who will write for them.

JOY INVENTIONS.—Messrs. David Joy, Son & Pryor have appointed Thorpe, Platt & Co., 97 Cedar street, New York, American agents for their assistant cylinders for valve gears, which have become so extensively used. Among the ships recently fitted with this system is the *Kasagi*, built by the Cramp Co. for the Japanese navy. The new agents will be prepared to give any information to inquirers regarding this specialty.

UNION STEAM PUMPS.—A recent copy of the "Journal," Battle Creek, Mich., gives an interesting article regarding the development of the Union Steam Pump Co., showing the steady growth from a small establishment to the large concern which now gives employment to many mechanics. An addition has recently been built to the works increasing the shipping facilities and making the handling of heavy pumps much easier. The general type of this company's pumps is shown in the advertisement elsewhere in this issue.

NATIONAL PNEUMATIC TOOLS.—The pneumatic tool business has been especially brisk of late, particularly so with the National Pneumatic Tool Co., 18 South Fifteenth street, Philadelphia, Pa. This company recently succeeded to the business of the Haeseler Co., and its business the first month was four times that of the previous company in its best month. Besides orders from many large manufacturing establishments, ten tools were sold to the Atlantic Works, East Boston, Mass., and to other shipbuilding companies.

EDUCATION BY CORRESPONDENCE.—Attention is called to the announcement in this issue of the American School of Correspondence, Boston, Mass. The school offers special advantages to readers of MARINE ENGINEERING to secure an education, enabling them to pass Government examinations. The object of the school is to give the busy man a thorough training in steam, electrical and mechanical engineering by mail. The steam engineering courses are carefully supervised by experts and are in close touch with the developments of the age. The instruction is carefully graded, thoroughly practical and scientific, and is intended to give engineers a complete technical training. The school is chartered by the Commonwealth of Massachusetts, and is strictly an educational institution and not a money-making enterprise, therefore the tuition fee is placed within the reach of all wage-earners. Engineers will do well to write for a handbook.

WALWORTH MFG. CO., 14-24 OLIVER ST., BOSTON.

Specialty of **BRASS VALVES** and Fittings for MARINE CONSTRUCTION

Extra Heavy Valves, Vent Pipe and Fittings for High Pressure Work.

SOLE MANUFACTURERS OF

VAN STONE PIPE JOINT

Which does not Weep under heavy pressure.

SEND FOR CATALOGUE. Prices and Terms on Application.

A Large Order.—The William H. Horstmann Co., Philadelphia, Pa., has recently been awarded an order by the Army Quartermaster for 100,000 hats. It will be remembered that this company makes a specialty of uniforms, hats, flags, etc.

Cape Cod Folding Anchors.—Yachtsmen will be interested in the Cape Cod folding anchor, which is being put on the market by Wilcox, Crittenden & Co., Middletown, Conn. Circulars and full information are issued by the company and can be had upon application.

Chicago Office of the C. & C. Co.—The new office of the C. & C. Electric Co. in Chicago will be at 828 Monadnock Block, where Mr. E. Sanderson, the company's new manager, will be glad to welcome all the old friends and customers of the company. Mr. Sanderson will look after all the territory tributary to Chicago.

Electrical Instruments.—Owing to the great demand for its various kinds of electrical instruments, of the Weston Electrical Instrument Co., Newark, N. J., has been obliged to build an entirely new factory at Waverly, N. J. This establishment when finished will be one of the most complete manufacturing plants in the country.

Morse Iron Works.—The U. S. transport *Hooker*, formerly the Spanish steamer *Panama*, which has been made a cable ship by the Government, was refitted at the Morse Iron Works, foot of Twenty-sixth street, Brooklyn, N. Y. She is now a first-class cable ship, and will be employed by the Government in laying cable at the Philippine Islands.

A Large Order for Babbitt Metal.—Merchant & Co., Philadelphia, Pa., recently received an order for a carload of their well-known babbitt metal. There has also been a large demand for this company's well-known iridium anti-friction metal. This is a mixture which many of our readers interested in babbitt should write to this firm to inquire about.

Indicator Work.—Everything necessary for indicator work is the special business of Richard Thompson & Co., 120 Liberty street, New York, who handle the Bachelder adjustable spring indicator and the Ideal reducing wheel. This company also sells the well-known Thompson grate bars and Thompson patent "soot sucker" boiler tube cleaner, which has been on the market for some years. Circulars regarding these specialties are issued by the company.

A Fine Electric Plant.—The Bullock Electric Mfg. Co. moved into its plant at Norwood, a suburb of Cincinnati, in December, and at present, although the increased facilities have more than trebled the output, it has so much work ahead that the shops are now working night and day. When this firm had its factory in Cincinnati it was recognized as one of the large electrical establishments, but the new plant is believed to be, next to the General Electric Co. and the Westinghouse Mfg. Co., the largest electrical establishment in America. No plant is better equipped for turning out work. All machine tools are driven with individual motors, and the entire absence of belts and shafts makes it a novel factory which is well worth a visitor's time to inspect.

ZINC WHITE IN MARINE PAINTING.

Within a few years after the discovery of the modern process for making zinc white, the French naval authorities, after severe tests, ordered its use to the exclusion of white lead on the interior of all vessels of the French navy. Experience has confirmed its superiority for painting structures exposed to sea-air and sea-water, and the French navy as well as the French steamship companies now universally employ it, while it is also the official base for painting lighthouses and Government work on the seashore. The French Marine authorities also use it for painting galvanized iron plates, the hulls of torpedo boats, the shells of metal pontoons, etc.

That the French navy should have been earliest to adopt this practice is natural, since zinc white was first generally introduced in France. But the naval authorities of the United States, having made their own experiments with the same results, have adopted zinc white as the fixed component of all paints used either in the Navy or by the Lighthouse Establishment. The famous "White Squadron" obtained its color from zinc white, and remained white because zinc does not change color. Ten tons of American zinc white is the cruising allotment for each ship, and it is used liberally and effectively.

Similar testimony is found in the U. S. Lighthouse specifications, which require, for white, a mixture of one-fourth lead and three-fourths zinc, and for tinted paints, American zinc white and yellow ochre, with no lead. "The colored paints are wanted for outside use and are required to withstand the bleaching effects of salt water and sunlight."

The durability of zinc white is due to its chemical stability and to the large proportion of oil it carries to the painted surface. No other white pigment approaches it in this respect. It is the one white paint material that is capable of resisting salt water and salt air. Added to other materials it shields them and gives them durability.

Advt. NEW JERSEY ZINC CO.

The Warren Steering Gear.—This steering gear, which was formerly manufactured by the Marine Machine & Conveyor Co., will now be put on the market by F. C. Sayles, a capitalist of Pawtucket, R. I., who has bought out the company. It is understood that he will reorganize the company and increase the manufacturing facilities so that this steering gear may be given its proper place in the shipbuilding world.

Hydraulic Tools.—William H. Wood, Media, Pa., who makes a specialty of hydraulic tools, has recently filled several large orders, among them a riveting plant for Thompson Kingsford, Oswego, N. Y., whose marine boilers are well known to our readers; a large hammer for the Navy Yard on Puget Sound; several large traveling cranes for the Burlee Dry Dock Co., Port Richmond, N. Y., together with many other tools to concerns which build boilers and do other work, but which are not marine.

Weston Standard Portable Direct Reading Voltmeter.

WESTON STANDARD PORTABLE

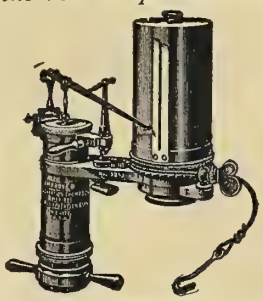
DIRECT READING

VOLTMETERS, AMMETERS, MILLIVOLTMETERS, VOLTAMMETERS, MILLIAMMETERS, OHMMETERS, PORTABLE GALVANOMETERS, GROUND DETECTORS AND CIRCUIT TESTERS.

Our Portable Intruments are recognized as **THE STANDARD** the world over. Our **VOLTMETERS** and **AMMETERS** are unsurpassed in point of extreme accuracy and lowest consumption of energy.

WESTON ELECTRICAL INSTRUMENT CO.,
114-120 William St., NEWARK, N. J., U. S. A.

HAVE YOU TRIED IT?
EUREKA!!! *Many Engineers say it wears fully 3 times longer than any other, and keeps the rod in splendid order. If you use a flexible PACKING, it will pay you to try EUREKA. We are sending out a tony photo on 8x10 cardboard for one 2c. stamp.*



SEND FOR ONE.

INDICATORS. Push yourself ahead by owning one. We will make price meet your views.

SEND FOR CIRCULAR.

Jas. L. Robertson & Sons,
218 Fulton St., NEW YORK.
Branches: BOSTON, PHILADELPHIA.

PARAGON BOILER.—We are informed by Capt. M. DePuy, 19 South street, New York, that he has closed an arrangement with the Marine Iron Works, Chicago, Ill., by which they have the shop rights to build the Paragon boiler for a term of five years.

BIG ENTERPRISE IN HAVANA.—Krajewski, Pesant & Co., 32 Broadway, New York, and proprietors of the Erie Basin Iron Works in Brooklyn, are reported to have purchased a large amount of land across the bay from Havana and have engaged Andrew Gunderson to go to Havana as resident manager of the new plant. Mr. Gunderson will have the supervision of the construction of a floating dry dock with a metal sheathed bottom, 220 ft. long and 90 ft. wide on the floor. In addition to the dry dock, plans are drawn for a pier at Regia, 276 ft. long, which will be pushed rapidly to completion, where ships of large draught will be enabled to unload. Mr. Gunderson will also have charge of the construction of modern machine shops, boiler shops, electrical works and brass and iron foundries.

Westinghouse

Direct and Alternating Current Generators and Motors, Switchboards and Apparatus

Westinghouse Electric & Mfg. Co.,
PITTSBURG, PA.

And all Principal Cities in U. S. and Canada.
Westinghouse Electric Co., Ltd.,
32 Victoria St., London, S. W., England.

Steam and Gas Engines, Mechanical Draft, Mechanical Stokers, Refrigerating and Ice Machinery

Westinghouse Machine Co.,
MANUFACTURERS

Westinghouse, Church, Kerr & Co.,
ENGINEERS

New York Pittsburg Philadelphia
Boston Detroit Chicago Buffalo
And all Foreign Countries

The name WESTINGHOUSE is a guarantee

91-B 1-25-99

THE U. S. METAL POLISH.—This polish is a fluid which gives quick results, and which is particularly well adapted to outside work in cold weather as well as hot. It is manufactured by George W. Hoffman, 295 East Washington street, Indianapolis, Ind., who will send circulars upon application.

CONSOLIDATION OF PNEUMATIC INTERESTS.—The Pneumatic Supply & Equipment Co. has been organized under the laws of the State of New York, and has opened an office at 120 Liberty street, New York. It is the purpose of this company to deal generally in compressed air equipment, and it will make a specialty of the installation of complete plants. Mr. J. W. Duntley, the president of the Chicago Pneumatic Tool Co., is the president of the new company; Mr. E. B. Gallaher, formerly with Messrs. Patterson, Gottfried & Hunter, is the vice-president and engineer, and Mr. W. P. Pressinger, formerly manager of the Clayton Air Compressor Works, is the secretary and treasurer.

SEARCH LIGHT PROJECTORS.—The Carlisle & Finch Co., Cincinnati, manufacturers of electric search light projectors, report business as excellent. It has lately secured orders for several large projectors for the U. S. Navy, as well as a large number for use on the lakes, Pacific Ocean and Western rivers. The projector made by this company will burn in any position and the arc is always maintained at the proper length, irrespective of friction of the mechanism or dirt on the moving parts. This company reports that its search lights are in use on all the Western rivers, and that some of the largest steamboat companies have adopted them exclusively.

A SHIPBUILDING RECORD.—The Harlan & Hollingsworth Company, Wilmington, Del., in the year 1898-9 has exceeded in the amount of construction all previous years. It has launched or contracted for nine coastwise steamers, one river steamer, one yacht, three ocean-going tugs and three torpedo boat destroyers, seventeen in all; steel steam yacht Niagara for Mr. Howard Gould, of New York City, triple expansion surface condensing engines; thirty knot torpedo boat destroyer Stringham, for U. S. Government, two triple expansion surface condensing engines, four Thornycroft boilers; steel sea-going propeller tug boat Gettysburg, for the Reading company, one triple expansion engine; steel twin screw steamer Tennessee, for the Baltimore Steam Packet Company; steel single screw freight steamer S. T. Morgan, for the Virginia-Carolina Chemical Company, Richmond, Va., triple expansion surface condensing engine; steel single screw sea-going tug Valley Forge, for the Reading Company, and exact duplicate of the Gettysburg; steel harbor tug Gem for the Standard Oil Company, of New York; steel single screw coastwise steamers Kershaw and Nantucket for the Merchants and Miners Transportation Company, triple expansion surface condensing engines; two thirty-knot torpedo boat destroyers, Hopkins and Hull, two direct acting triple expansion engines, four Thornycroft boilers; two single screw freight and passenger steamers Ponce and San Juan, for the New York & Porto Rico S. S. Company, triple expansion surface condensing engines, Ellis & Eaves induced draught; single screw freight and passenger steamer Maracaibo, for Messrs. Boulton, Bliss & Dallett, Red D Line, triple expansion surface condensing engine; single screw freight and passenger steamer known as Winsor Ship No. 4, for the Boston and Philadelphia S. S. Company, inverted triple expansion engine; two freight steamers for the outside line between New York and Baltimore, for the New York and Baltimore Transportation Line, triple expansion engine. Congress, at last session, made a very large appropriation for widening the Christiana river and deepening it to a uniform depth of twenty-four feet at mean low water, and as there is a rise and fall of between six and seven feet in the tide at Wilmington, the Harlan & Hollingsworth Company contemplate building a 600-ft. ways.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

TRIPLE EXPANSION ENGINE FOR SALE.

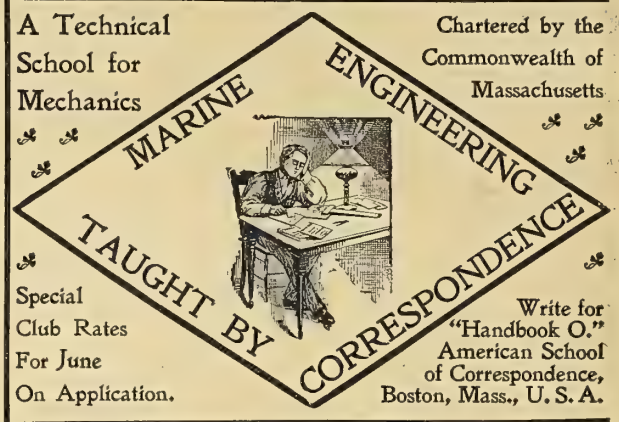
A fine new 4-cylinder triple expansion engine, cylinders 18.26½ and two 27 lows x 18 stroke. Suitable for yacht. Can be bought cheap. ALFRED BOX & CO., Front and Poplar Sts., Philadelphia.

COPPERSMITH FOREMAN SEEKS POSITION.

Situation wanted as foreman in coppersmith work, by man of many years' experience in government and merchant marine work.
COPPERSMITH, care MARINE ENGINEERING,
World Building, New York.

BARGAIN IN STEAM YACHT.

A fine yacht, 50 feet over all. Able seaboat, compound engine, water-tube boiler, quarter boats, awning, and everything complete; for sale at a great bargain.
STEAM YACHT, care MARINE ENGINEERING,
World Building, New York.


A Technical School for Mechanics
Chartered by the Commonwealth of Massachusetts
MARINE ENGINEERING
TAUGHT BY CORRESPONDENCE
Special Club Rates For June On Application.
Write for "Handbook O." American School of Correspondence, Boston, Mass., U. S. A.

SEPARATORS FOR WAR VESSELS.—The Harrison Safety Boiler Works, Germantown Junction, Philadelphia, Pa., have just supplied the U. S. Government three separators for the vessels captured from Spain during the war in Cuba.

SCHOOL OF NAVIGATION.—A school of navigation, under the charge of R. M. Pugsley, 146 West Twenty-third street, New York, offers a course preparing candidates to pass all the requirements of the U. S. Local Inspectors of Steam Vessels.

BEARING METAL.—We are informed by J. J. Ryan & Co., 68 West Monroe street, Chicago, Ill., that they had an experience with the bearing-crank pin-box on an engine which was continually running hot under heavy loads. This firm applied its well-known Nickel brand of babbitt metal where the trouble was experienced, and no further trouble resulted. This firm has established a large trade with shipbuilders and builders of engines.

BELKNAP ELECTRICAL SPECIALTIES.—Owing to the large demand for their various specialties, the Belknap Motor Co., Portland, Me., has opened an office at 9 Maiden Lane, New York, under the charge of A. W. Koenig, who will handle the Chapman voltage regulator, electric controllers and direct connected electric plants manufactured by this company. Among the specialties is a marine motor of the multipolar type, such as is now in use on many Government vessels, and which is especially adapted to hoisting anchors, boats, sails, etc.

ALCO VAPOR LAUNCHES.—The Marine Vapor Engine Co., Jersey City, N. J., has never been busier than this spring. Among recent orders are a 21 ft. carvel launch with 3 horse power alco vapor engine, for C. H. Thompson, Brattleboro, Vt.; an 18 ft. yacht tender for schooner yacht *Katrina*. The gratings of this boat are American elm, and the engine is a 3 horse power alco vapor. The company also has an order for a 26 ft. launch for the U. S. Revenue Cutter Service, with awnings, storm cushions, pantasote cushions, and to be equipped with a 5 horse power alco vapor engine.